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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.....525, 545

TECHNICAL ARTICLES:

The Harlem River Bridge at 155th St., New York City (*illustrated*)..... 526
The New Water Supply for Atlanta, Ga..... 527
On the Elastic Curve and Treatment of Structural Steel..... 528
A Convenient Wheel-Base Moment Diagram (*illustrated*)... 528
Desulphuration of Pig Iron by Manganese (*illustrated*)..... 529
Notes on a Problem in Water Power..... 530
A Proposed Rapid Transit System for Montreal (*illustrated*) 531
Standard Buildings on the Macon & Birmingham R. R. (*with inset*)..... 531
The Cast Iron Pipe Trade..... 531
Screw Piles in Germany (*illustrated*)..... 532
Pelton Wheels Under 2,100 Feet Head..... 538
How to Place Steam Valves..... 538
New Harbor at Malmo, Sweden (*illustrated*)..... 538
World's Columbian Exposition..... 539
Fuel Gas Production (*illustrated*)..... 540
The Engineering Schools of the United States—X..... 541
Erecting the Kentucky River Bridge at Irvine, Ky. (*illustrated*)..... 543
The New York and New Jersey Bridge Co..... 544
Gates on Force Mains..... 544

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS.....532—535

EDITORIAL NOTES 536

Architects for Government Buildings—The Indianapolis Cattle Guard Tests—The House Committee Report on the World's Columbian Exposition—An Announcement by the Am. Soc. C. E. Publication Committee

EDITORIALS:

Whist Hands and the 'Doctrine of Chances"..... 537

CORRESPONDENCE..... 538

The Poughkeepsie Bridge—Garbage Cremation—Ship Railways in Europe.

CONSTRUCTION NEWS..... 545-548

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

Surveys and soundings are being made for the anchorages and piers of the proposed new suspension bridge across the East River between New York and Brooklyn. The bridge will be located about one mile north of the present bridge; its New York terminus being at a point between Delancey and Rivington Sts., near Sheriff St., and its Brooklyn terminus at a point between South Fifth and South Sixth Sts. It will be similar in style and construction to the present structure, with the exception of the piers, which will be of granite masonry to a point above the driveway, about 150 ft., only, and above that of steel columns. The piers will be 280 ft. high and will support four steel wire cables, each 19 ins. in diameter, carrying a center span 1,620 ft. long, or 25 ft. longer than that of the present bridge. The total width of the bridge will be 106 ft., and there will be four railway tracks, two driveways and a promenade. Its height above low water will be 135 ft. at the center and 119 ft. at the piers. The detailed plans are now nearly completed, and it is stated that work will begin on the approaches as soon as the right of way can be obtained. The bridge is being built by the East River Bridge Co., which is backed by the Union Elevated Ry. Co., of Brooklyn, N. Y., under a charter granted by the last New York State Legislature. The officers of the East River Bridge Co. are, Pres., Frederick Uhlman, Vice-Pres., Jacob Ruppert, Secy., Elisha Dyer, Jr.; Treas., George W. Wingate, and Ch. Engr., George B. Cornell. We expect to give a complete description of this structure in a future issue.

The Chicago Railway Terminal Commission, which was appointed about two months ago by Mayor Washburn (Eng. News, April 2) has been discharged by vote of the City Council after it had presented a preliminary report upon the terminal arrangements in other cities. Some of the Aldermen are said to have considered that the committee's work would be too expensive, as it was expected to last two or three years. Meantime the very important question of providing terminal facilities and eliminating grade crossings remain in abeyance.

The electric railways to be built by the Atlantic Ave. Ry. Co., of Brooklyn, N. Y., will have three kinds of track, the rails being furnished by the Lewis & Fowler Girder Rail Co., the Duplex Street Railway Track Co., and the Pennsylvania Steel Co. The Samson bridge joint, made by the Tramway Rail Co., of Pittsburg, will be used with the latter. The ties will be of Florida pine and Connecticut white oak, 5×9 ins., spaced 30 ins. c. to c. Tubular poles, 28 ft. long, will be furnished by Wallace & Co., of New York, and will carry span wires, except on Ninth Ave., where the poles will be on one side of the street, with a 15-ft. bracket extending over the tracks. The St. Louis Car Co. will build 50 cars, 27 ft. long, with bodies 18 ft. 6 ins. long, carried on Peckham motor trucks, and equipped with two 30 HP. Westinghouse single reduction motors. The power plant will consist of four Corliss tandem compound condensing engines, one of 350 HP., and three of 500 HP., with three batteries of Babcock & Wilcox boilers, each battery consisting of two 250 HP. boilers, 23 ft. long, with tubes ¼-in. thick. There will be four Westinghouse generators, two of 400 HP., and two of 700 HP. A part of the line is expected to be completed by July.

The gross and net earnings of railways in the United States for March and the first quarter of 1892 are as follows, according to the "Financial Chronicle:"

	March (131 roads)		
	1892.	1891.	Inc. p. c.
Gross earnings	$61,080,993	$55,393,342	10.27
Oper. exp.	42,352,460	38,922,831	8.7
Net earnings	$18,728,533	$16,470,511	13.10
	Jan. 1 to April 1 (208 roads)		
	1892.	1891.	Inc. p. c.
Gross earnings	$227,564,220	$208,998,864	8.88
Oper. exp.	163,257,264	150,199,392	8.7
Net earnings	$64,306,956	$58,799,472	9.37

The gain has been quite general throughout the country. All of the several groups show increases in gross earnings over last year's figures, both for March and the three months, and all but the Southern group exhibit increases in net, and in this group the decrease has been very small, in fact, much smaller than was anticipated. Some very large increases are shown by individual systems. For March, gains of $996,128, $763,477, $665,196 and $609,148, respectively, are shown by the Pennsylvania, Chicago, Burlington & Quincy, Philadelphia & Reading, and Chicago, Milwaukee & St. Paul systems, and for the three months the same systems show gains of $1,899,765, $2,272,927, $1,718,838 and $1,508,979, respectively.

The most serious railway accident of the week was a head collision May 21, on the St. Louis Southwestern Ry., between Humphreys and Golden, Ark. A northbound passenger train had orders to pass a southbound freight train at Humphreys, but ran beyond that point in violation of orders, and collided with the freight train on the Crooked Bayou trestle. The shock threw some of the passenger cars off the trestle into the water, and eleven persons were killed and about twenty injured.—A pile culvert near Concordia, Kan., on the Missouri Pacific Ry., gave way under a circus train May 17. Several cars were wrecked, and two men were killed and four injured. The culvert had been weakened by floods.

Two locomotive boiler explosions are reported: One near Newcastle, Wyo., on the Burlington & Missouri River R. R., May 15, and the other at Billings, Mont., on the Northern Pacific R. R., May 17. Both were freight engines. In the first case, one man, and in the second case, two men were killed.

The floods in the Missouri and Mississippi valleys still continue, and much interference to railway traffic has been caused by washouts, damaged structures and flooded tracks. Sioux City, Ia., has suffered severely in loss of life and damage to property, and all through the South great tracts of land are under water.

By the bursting of the main steam pipe supplying the engines of the Electric Light Co., the city of Detroit was left in darkness on the night of May 17.

A recent fire in a Cleveland theater was found to have been due to an unusually idiotic piece of work in the electric wiring. An insulated wire was wound around a gas pipe, and during a thunder storm the insulation was pierced and two holes were burned in the pipe, permitting the escape of the gas.

The Coroner's jury in the Roslyn Mine disaster in Washington brought in a verdict that the explosion which caused the death of 45 miners was due to an accumulation of fire damp, caused by deficient ventilation. Much of the testimony before the jury, however, went to show that the mine was fairly well ventilated, and that the explosion, while started, perhaps, by a sudden outburst of gas, was chiefly a dust explosion.

A rear collision of cable car trains occurred in the Washington St. tunnel, Chicago, Ill., on May 17, by which four persons were injured. The front train stopped at the bottom of the grade, and the brakes refused to act on the heavily loaded train which was following.

Air brakes for freight cars and driver brakes for locomotives were advocated by special resolution at the recent annual convention of the Brotherhood of Locomotive Engineers, held at Atlanta, Ga. The substance of the resolution was as follows:

Whereas, The application of power brakes to freight cars has now passed the experimental stage, and the safety of train and trainmen is so greatly enhanced that it is now nearly akin to criminal neglect to allow trains to be run without such power brakes,

Resolved, That we deem it a duty we owe to ourselves, to our families, to the companies for whom we work and to the great general public, that we respectfully request of all railroad corporations that from now on all new equipments and all repaired cars shall come into service fitted up with a power brake, so that the engineer drawing such cars can have constant and immediate control of the brakes.

Resolved, That we favor and respectfully and earnestly ask for such national legislation as will require all railroad corporations to equip within a reasonable time every locomotive with driver brakes, and a sufficient number of freight cars with power brakes, so that every freight train engaged in the interstate or foreign commerce of the nation shall always have enough cars in such trains equipped with power brakes under the control of the engineer as to enable him to at all times to control his train without calling on the brakemen to use the hand brakes for this purpose. We also earnestly urge upon Congress the imperative necessity of some wise legislation to bring about a uniform method of coupling cars automatically.

An electric motor car for use on steep grades has been designed by Messrs. Harry L. Van Zile and Frank Chrysler, of Albany, N. Y. The electric motor drives two horizontal wheels, which grip a central rail. The motor wheels are mounted on arms at such an angle that the greater the tractive force exerted the greater is the pressure of the grip wheels on the rail. In a recent trial, a motor car weighing about 4½ tons, was propelled up a 30% grade.

Two 5,000 HP. turbines have been ordered by the Cataract Construction Co., from Foesch & Piccard, of Geneva, Switzerland, for the Niagara Falls power plant. They will be placed in the great wheel pit now being excavated, which is 140 ft. long, 18 ft. wide and 170 ft. deep.

The Falls Hollow Staybolt Co., of Cuyahoga Falls, O., recently sent a specimen of its mandrell-rolled hollow staybolt iron to the laboratory of physical tests of Washington University, St. Louis. The metal when tested showed 34% elongation, 50% reduction of area and 49,200 lbs. ultimate strength. The following is Prof. Johnson's report of the test:

Size of test pieces	0.895 ins. diam., 10½ ins. long
Inside diameter	3-16 ins., hole at center
Area, in sq. ins.	0.601
Ultimate strength, lbs.	29,600
Ultimate strength per sq. in., lbs.	49,200
Limit of elasticity, lbs.	17,000
Limit of elasticity, lbs. per sq. in.	28,300
Elongation of reduced section in 5 ins.	1.70 ins.
Per cent. of elongation	34.0
Area of reduced section, sq. ins.	0.30
Per cent. of reduction	50

This is a remarkably fine specimen of wrought iron for staybolt purposes. Its elongation, 34%, is the greatest I have ever found for wrought iron, and this is of the utmost importance in staybolt iron. The fracture shows a pure, fibrous, unlaminated and uncrystalline structure.

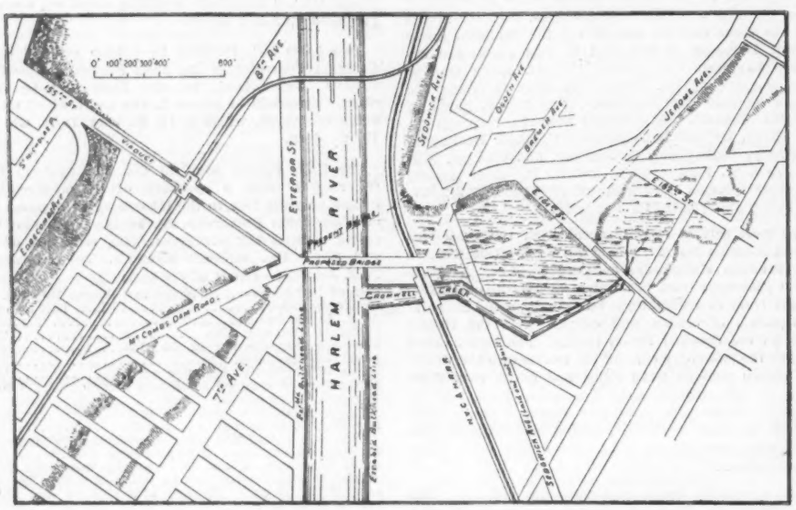
A nickel steel, 8-in. gun has been ordered by the Ordnance Bureau of the Navy Department as an experiment, and will be made at the Bethlehem Iron Works. It is said that the metal is to contain 3% of nickel.

Official tests of Ericsson's torpedo boat "Destroyer," or rather of the submarine gun attached to the vessel, have been in progress this week at the Brooklyn Navy Yard. This gun fires a torpedo having about the specific gravity of water, so that its weight does not deflect it from its course. The torpedo used is about 20 ft. long and 16 ins. diameter in the body, and is intended to carry 300 lbs. of explosive. The tests were made by filling the timber dry dock at the Navy Yard with water, and stationing the "Destroyer" opposite its entrance. The torpedo was fired toward the rear end of the dock, and nets were stretched at 100 ft. intervals across the dock to register the course of the projectile. The result of the tests have been rather disappointing. Fired with a charge of 25 lbs. of powder, the effective range of the projectile appears to be only about 700 ft. The course of the projectile seems to be rather erratic, veering to the right or left and turning up or down without apparent reason. It is possible, however, that these variations in its course are due to the obstructions offered by the nets.

A consolidation of the various manufacturing interests of the Carnegies, of Pittsburg, Pa., will, it is stated, be made under the name of the Carnegie Steel Co., Limited. The consolidation will include the great iron and steel firms of Carnegie, Phipps & Co., Carnegie Bros. & Co., the Keystone Bridge Co., and the Edgar Thomson Steel Works, and other smaller firms in which the Carnegies are interested; and possibly the Frick Coke Co., which practically controls the coke trade of the Connellsville region. The total capitalization of the consolidated company will be about $15,000,000. July 1 is named as the date of the consolidation.

THE HARLEM RIVER BRIDGE AT 155TH ST., NEW YORK.

With the growth of the northern suburban district of the city of New York comes an increasing demand for better communication between the parts east and west of the Harlem River valley. At present there are but two first-class modern bridges over the river west of Third Ave., the Washington Bridge at 181st St. (Eng. News, Dec. 27, 1890), and the High Bridge at 173d St., the latter being available for foot passengers only, and only intended to carry the old Croton aqueduct across the river. There is now a very heavy driving traffic in this part of the city, and a large part of this crosses the old McComb's Dam Bridge, which is an old low level wooden bridge, at the location shown on the accompanying plan. The city decided about a year ago to build a large iron bridge here, with viaduct approaches, connecting the high ground on either side of the river. The contract for the western trestle approach was let last year to Mr. Herbert Steward, with the Union Bridge Co., as sub-contractors for the metal work, and the Hecla Iron Works as subcontractors for the ornamental railings and the staircases. The consulting engineer for the entire work is Mr. A. P. Boller, and the contract for the



MAP SHOWING LOCATION OF HARLEM BRIDGE AND VIADUCT AT 155TH STREET, NEW YORK.

construction of the bridge and eastern approach has been very recently awarded to the Passaic Rolling-Mill Co., Paterson, N. J., as noted in our issue of March 19. The new bridge will cross the river at 155th St., and will be about a mile below High Bridge and 1¼ miles below Washington Bridge. The accompanying map shows the location of the bridge and viaduct approaches, and the two views represent the condition of work on the western trestle approach on April 23 last. Fig. 1 is a view taken from the eastern end, looking from the top of the bluff at Edgecombe Ave., 60 ft. above 155th St., and shows in the middle distance the elevated railway on Eighth Ave. below, and in the far distance the old wooden bridge which is to be replaced. Fig. 2 shows the viaduct crossing the elevated railway.

The viaduct which constitutes the western approach will be 1,400 ft. long, with a grade of 4¼% toward the river, and will be 60 ft. high at Edgecombe Ave., 48 ft. at Eighth Ave., and 28 ft. at the river. A wide plaza, which is seen from below in Fig. 2, extends over Eighth Ave., with stairways of somewhat novel design, which we will show later, to the railway station and the street. The spans are 43 ft. c. to c., with columns 18 ins. square on concrete piers with pile foundations. The columns of alternate spans are connected by struts and braces. The roadway is 40 ft. wide, with two sidewalks 11 ft. wide each, projecting beyond the outside longitudinal plate girders. The floor is of buckle plates covered with bituminous concrete, with 6-in. granite block paving for the roadway and asphalt for the sidewalks.

The triangle between McComb's Dam Road, Seventh Ave. and 153d St., has been acquired by the city, and will be so altered as to form an easy approach from Seventh Ave. North of the river, the marshy tract shown on the map will, in course of time, be filled in and made available for building. Private enterprise is relied upon to do this and very much more in the way of improvement of the extensive and important district which the bridge will put in direct and better communication with the island part of the city. The Harlem River is shown on the map restricted within the proposed bulkhead lines, which as yet are mostly on paper only. We published in our issue of March 19 the detailed bids for the construction of the drawbridge and of its eastern approach, the contract for which was awarded to the Passaic Rolling Mill Co., with Herbert Steward as subcontractor for the masonry and Sooysmith & Co. as subcontractors for the pneumatic foundations. The work consists of a draw 408½ ft. c. to c. of end pins, and 16 spans of lattice girders of 83 ft. each, leading from the east shore of the Harlem on the line of the bridge over the tracks of the New York Central & Hudson River R. R., and from there on a curve of 1,500 ft. radius to an abutment on the north side of 161st St. Between 161st and 162d Sts. the approach is an embankment between masonry retaining walls. A viaduct starting east of the New York Central tracks and forming a connection with Ogden Ave. is contemplated for the future.

The foundations of the west and pivot piers for the draw will be sunk by the pneumatic process with steel caissons. The east pier will be built inside a coffer-dam and the land piers are to be founded on piles. The piers will be of granite, all courses above mean high water being of dimension stones. The body of the piers is to be a dark stone, relieved by a light-colored granite for coping, necking and weathering courses. The railings and lamps for the structure will be of highly ornamental character.

The bridge will be essentially of the same type as the Thames River draw at New London, Conn., illustrated in our issue of Aug. 16, 1890, and will have nine panels of 21 ft. 3 ins. long. The center posts will be 62 ft. 6 ins. c. to c., and the end portals will give a clearance of 25 ft. The distance c. to c. of trusses is 43 ft. 6 ins., giving a roadway of 40 ft. between curb girders. Two sidewalks of 10 ft. 6 ins. each are overhanging, making the total width of the bridge 69 ft. over the wrought iron cornices. The bridge will give a clear headway of 29 ft. above high water. The paving will be asphaltum concrete, laid on buckle-plates, with a wearing surface of rock asphalt. The sidewalks are also to be of asphalt. The weight of the draw is nearly 2,400 tons, which an elaborate system of girders distributes equally over 16 equidistant points of a circle of 40 ft. 5 ins. diameter. From these points, 16 diaphragms carry the weight to 32 points of two concentric drums. These drums are 4 ft. 10 ins. and 5 ft. deep, with diameters of 36 and 44 ft. respectively, and bear each on 64 wheels of cast steel. The draw is turned by two pinions, gearing in a rack of cast steel 10 ins. deep. The engine, boiler and compressors for the working of the hydraulic end rams and of the hydraulic end brake are located in a spacious room inside of the turntable.

Each span of the lattice girders consists of six girders 7 ft. 3 ins. deep, the weight of the approaches aggregating 2,700 tons. The width of roadway and of the sidewalks and the material for the paving, are the same as for the draw span. The bridge and the approaches will be built of soft steel. The approaches are level from the bridge to the east of the railway tracks, and give a uniform down grade of 1° from this point to Jerome Ave.

The draw and the approaches, the appropriation for which amounts to $1,250,000, are built under the jurisdiction of the Department of Public Works, for which Mr. Martin Gay, M. Am. Soc. C. E., acts as engineer, and according to the designs and specifications, and under the supervision of Mr. Alfred P. Boller, M. Am. Soc. C. E. Dredging was begun on the site of the west bridge pier last week, preparatory to the sinking of the caisson, and it is expected to finish the whole work by the end of 1893.

The new bridge, with the 155th St. viaduct, are but two of the parts of a grand system of improvements which will, probably within a few years, transform that entire section of the city of New York. The Harlem ship canal now in progress, the projected rapid transit railway, the completed Washington Bridge, the authorized Kingsbridge Road Bridge at 222d St., the proposed widening and improvement of Jerome Ave., with the existing elevated and surface railway systems, are the other features in the scheme of development.

THE NEW WATER SUPPLY FOR ATLANTA, GA. (a)

During the Cotton Exposition, which was held in Atlanta, in 1881, Mr. Emil Geyelin, of Philadelphia, the well known hydraulic engineer, called upon me and visited our pumping station; he noted the evident rapid growth of the city and remarked that we would soon outgrow our then present water supply, and asked me if I had given the subject of a more abundant supply any thought, and if so, had I any plan. I told him that naturally, in my position as Superintendent, my attention had been drawn to the increase in the consumption, and that I thought the future supply would be taken from the Chattahoochee River, at a point at which the stream could receive no contamination from drainage from the city, and that the particular spot would be just above the mouth of Peachtree Creek. This location is very favorable in many respects, as there are the valleys of the two large creeks which intervene between the city and the river. The city is laid out in a circle radiating from a center at the Union Passenger Depot, and this location on the Chattahoochee is protected absolutely from pollution until the city shall have grown beyond a diameter of 12 miles, and even then, at the expense of extending the pipe up the river, the intake may be protected indefinitely.

I may say that my general plan outlined to Mr. Geyelin in 1881 is substantially the one adopted, after going over the territory in almost every direction, and to almost every available source of supply. The city consulted Mr. Rudolph Hering, and he and Mr. Clayton, our able City Engineer, finally adopted the plan upon which the works are now being built.

The city datum is 1,050 ft. above the sea level; the river, at the point alluded to, is 700 ft. The difference is placed at 300 ft., although there are some localities within the city that are 40 ft. above this. The head to be overcome, to afford a satisfactory domestic pressure, would be 400 ft.; and, to furnish a pressure for fire purposes, including friction, a head above the river of 500 ft. This, while not being outside the line of possible good results from one set of pumps, was not deemed as safe as to divide the lift and erect two stations, one at the river and another at a suitable elevation that would about equally divide the head. The plant, when complete, will consist of two pumping engines of 10,000,000 gallons daily capacity each, at the river. These engines will discharge into a storage reservoir, whose surface will be 985 ft. above the sea, or 225 ft. above the river. At the level 945, or 40 ft. below the surface of the water in the reservoir, there will be located a filter plant which, at present, will have capacity for filtering from 6,000,000 to 8,000,000

(a) Slightly abbreviated from a paper by Mr. W. G. Richards, Superintendent of the Atlanta Water-Works, read before the American Water-Works Association, May 17, 1892.

gallons in 24 hours. The filters will discharge into a clear water basin holding 1,000,000 gallons, thence the water is taken, by a second set of pumping engines, and discharged through a 30-in. main pipe directly into the city distribution.

The pressure to be maintained, throughout the city, will, according to altitude, be from 40 to 60 lbs. as the regular or "domestic pressure," and, in the event of fires, will be from 80 to 100 lbs.

Just here it is well that a word or two be said to explain why preference is given to the direct pressure or Holly system. Atlanta is situated at the southern extremity of the Blue Ridge, and is on the highest spot of ground to be found within a radius of 50 miles, and, should the expensive luxury of an elevated reservoir have been contemplated, it would have been impossible to have found a location that would afford a satisfactory pressure for domestic uses, not to mention fire service.

Our citizens, the firemen, and the insurance companies have become used to an immediate fire pressure direct from the hydrants, and would now be very reluctant to accept any system that would require more time than a minute to obtain a satisfactory fire pressure. In my opinion, there is no substantial argument that can be brought against the direct pressure system if its application be correct. It is acknowledged that it will answer in cities of small area, which, in the opinion of the writer, is an acknowledgment that it will answer for cities covering the greatest area, and only requires that the main conduit branch to different pumping stations, at which district pumping engines be located, and by this means a pressure satisfactory for any and all purposes, or emergencies, would be obtainable, and the use of steam fire engines become of little need. New York, Chicago or London might as well have a good fire protection as the little city of Atlanta. I have given the general plan, and will now begin at the river, or station No. 1, and give some of the items of construction.

The Chattahoochee, at the point of intake, rises from the low water mark to a height of 26 ft. A dike or levee is being built to inclose about two acres, inside of which the engine house is being built. The intake is a 48-in. iron pipe 600 ft. long, the outer end of which will be about 1 ft. below extreme low water, and, having a fall of 1 ft. in its entire length, terminates in an elliptical shaped suction well, whose diameters are 30 and 60 ft. There are 30-in. suction pipes from this well to the pumps. The pumps will have a maximum suction lift of 16 ft., varying according to the stage of the river. There will be a valve on the intake pipe to control the height of water in the suction well, and there will also be a by-pass connection on the river side of the valve, and connections with the rising main to the reservoir to be used for the purpose of flushing and cleansing the intake. There is also provided a drainage well, within the dike inclosure, that may be pumped out in the event of any continuous high water.

The machinery at this station consists of two 10,000,000-gallon, horizontal, high duty, Gaskill engines. A 30-in. cast iron pipe will convey the water from these pumps to a storage reservoir at station No. 2, the distance being 17,000 ft., and an elevation above the pumps of 210 ft. The reservoir will have a capacity of about 180,000,000 gallons, and it is expected that this storage will tide over any unusual high water in the river, and afford an opportunity of stopping the pumps during seasons of heavy rainfall and consequent turbidity, and also to afford a supply should there anything happen to pumps or pipe line. It is contemplated that a parallel main will be run between the two stations in the future. The receiving reservoir is, happily, located in a deep ravine, and is formed by the construction of two dams, which cross at sufficient distance to embrace about 20 acres.

The natural levels of the sites selected all seem favorable for construction on the plan upon which the work

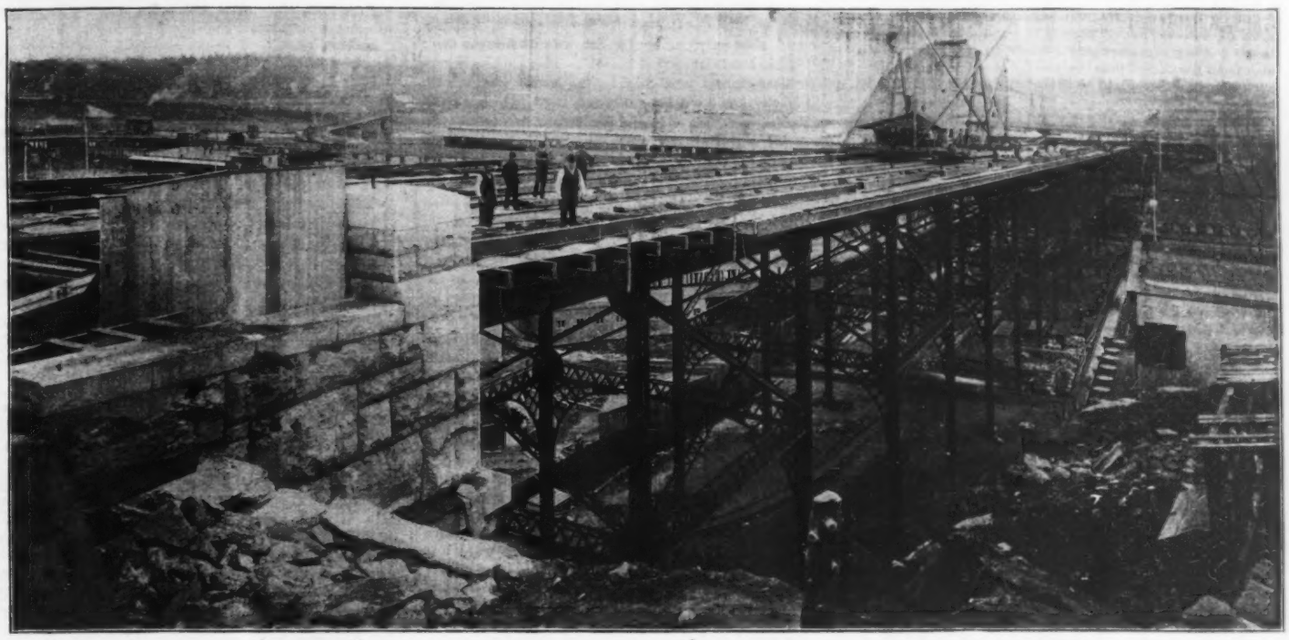


FIG. 1. HARLEM RIVER BRIDGE; VIEW OF WESTERN VIADUCT APPROACH FROM WESTERN END.

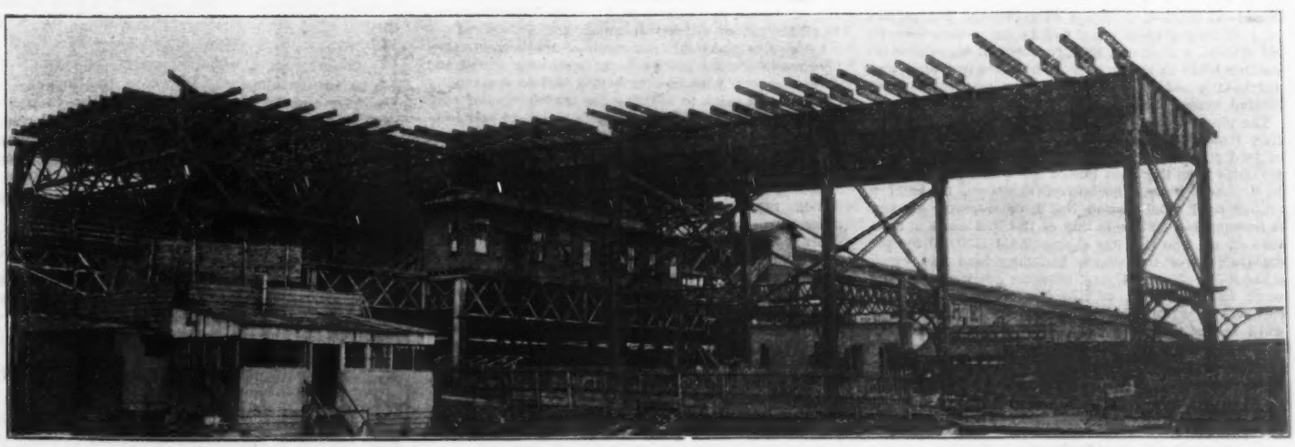


FIG. 2. HARLEM RIVER BRIDGE; VIEW OF WESTERN VIADUCT APPROACH CROSSING THE ELEVATED RAILWAY.

is being carried out. The streams of this section carry a large amount of the abounding red clay soil, the coloring matter of which is held in suspension for a long period, and the rivers rarely become clear until the effects of the rains have passed off, and the water from the springs, from which they derive their source, predominates. It may be possible to remove this coloring matter by settling basins; but this would be an expensive arrangement, and the gravity filter having proved a splendid success in the operation of the old works, it was decided to adopt it in the construction of the new plant. The filters at the old station are working very satisfactorily, with a gravity head of 20 ft., and it is expected that the new ones, which are to have a gravity head of 40 ft., will work to even a greater degree of satisfaction. There will be a 36-in. pipe extending from the storage reservoir to the filters, and also from the filters into the clear-water basin.

The clear-water basin will be built of brick and will be circular, 100 ft. diameter, 20 ft. deep, holding 1,000,000 gallons. When full, the water will be on a level with the floor line of the engine room. The situation is such that there is drainage with ample fall from the filter and engines at this station.

The machinery at this station consists of one high duty 10,000,000-gallon Gaskill engine, and one Holly quadruplex of 4,000,000 gallons daily capacity, the latter being one of those now in service at the old station, and which the Water Commissioners desire moved to use as a relief for the Gaskill, though it is hoped by the writer, and also by Mr. Clayton, the Engineer, that, as the work progresses, they may be persuaded to secure another Gaskill of the same dimensions as the first. It being of doubled policy, at best, to move a pump to this station which will fully supply the wants during the midnight hours.

Extending from station No. 2 into the city distribution is a 30-in. pipe for a distance of about 1½ miles; this will be distributed into one 20, and two 16-in., the latter going east and west, and the 20-in. pipe passing directly south through the center of the city.

This 20-in. pipe was connected with the old system at the start, and is being laid from the center out toward the pumping station and is also being connected at all convenient intersections on the line with the city distribution. This work is being done by the water department, and is being thoroughly tested as the work progresses. The valves on this line are about 1,000 ft. apart, and, as each section is laid, and before the ditch is filled, an air cock is inserted at the highest point in the section, and another at a low point; after all the air has passed off, a boiler test pump is attached at the low point and a pressure of 250 lbs. is applied, and if there are no leaks, the ditch is then filled. I am pleased to say that up to the present time I have not found a single faulty pipe, or special, in the ditch, and none outside excepting a few lengths that have been cracked in transit or unloading. I think this plan of testing pipe, when laid in connection with an old system, a good one, as it removes all uneasiness regarding leaks in the future. A hammer test and close overlooking before laying is all the test these pipes receive except the customary foundry test.

The pipe is being furnished by the Howard-Harrison Iron Works of Bessemer, Ala. There is 2 ins. depth of lead put in the joints. The station at the river is 1½ miles from the main line of the Western & Atlantic R. R., and it was necessary, therefore, to build a branch road. The station No. 2, or reservoir station, is immediately on a side line of the Richmond & Danville R. R. The city has appropriated $750,000 for the construction of the works, including land and every other item. The contracts, covering every part of the work, have been let, and, so far as can be seen, the cost will be within the sum of the appropriation. The work seems to be progressing very evenly. The engineering, in all its features, is under the direction of Mr. Robert M. Clayton, City Engineer, and a member of this association. The machinery and pipe laying are my part of the work.

ON THE ELASTIC CURVE AND TREATMENT OF STRUCTURAL STEEL.

This paper, read at the San Francisco meeting of the American Society of Mechanical Engineers, by Mr. Gus Henning, described the result obtained in tests of the material for the Ohio River bridge at Henderson, Ky., and was accompanied by voluminous tables and diagrams. The steel was tested after rolling into the finished shapes as well as in the shape of ¾-in. billets, rolled from each heat. The structure was built in 1884-5, when knowledge of structural steel was much more limited than at present. It is interesting to note that limits of carbon and of phosphorus were stated, but no upper limit for tensile strength. Steel in compression members was required to contain not less than 0.34% or more than 0.42% of carbon, and less than 0.1% of phosphorus. It was also required to show at least 50,000 lbs. elastic limit and not less than 80,000 lbs. ultimate strength. Elongation was to be 15% in 8 ins., and reduction of area, 30%. It was to be incapable of tempering, and a ¾-in. round was required to bend 180° around its own diameter without flaw or cracks.

The steel in tensile members had the same phosphorus limit, and an upper limit for carbon of 0.26%. The elastic limit requirement was 40,000 lbs., ultimate strength 70,000 lbs., elongation 20%, and reduction of area 40%.

All the analyses made at the steel works showed the phosphorus to be within the limits specified. Analyses made afterward, for another purpose, showed that only one heat in ten was within the limit and some heats exceeded it 50%. The author thinks this discrepancy was due to the great haste with which the steel works analyses were made, as the manufacturers honestly endeavored to furnish a high grade of material and took all possible precautions to that end.

The most interesting thing in connection with the treatment of the material was the annealing of some of the built up sections of the compression chord after they were assembled and riveted up. The structure being built of what would be classed nowadays as very hard steel, the annealing was especially important. We quote from the paper as follows:

As many of the plates and angles to be used in compression members were thin and wide, it was thought that annealing might become advisable to soften the material, which, during rolling, had perhaps become hardened to an undesirable degree. Experience obtained during fabrication, especially punching and shearing, demonstrated that annealing was really advisable, and therefore a number of finished chord sections—those which were built of thin shapes—were annealed, and without in the slightest degree injuring or distorting them or even loosening a single rivet.

It was noticed, however, that whenever there were open holes near the ends of angles, which were left for field connections and splice plates, the plates would become slightly longer than the angles; the difference in no case, however, amounted to 1-32 inch, and by taking a very light cut over the ends the total lengths would again become true and correct.

In order to determine whether the shape became at all distorted, chalk center-lines and others near the edges were struck (using a fine sea grass line), and after treatment and cooling these were invariably tested for accuracy without ever finding the slightest change or variation. Every rivet was also carefully tested at that time, and there never was a single loose one found in all the pieces so treated.

I desire to make this statement at the present time, because interested parties have repeatedly stated and do now assert, without ever having had an opportunity or taken the pains to examine the truthfulness of such statements, that annealing distorts members and loosens rivets. It is of such great interest and importance to all engineers and bridge builders to know that built sections—box shape with two or three webs—can be annealed without injury or distortion that I cannot emphasize this fact with sufficient clearness or force in order to contradict statements based on opinions only, and not upon experience or observation.

It must be borne in mind, however, that a certain and absolute method of treatment was adopted, which prevented any possible or accidental injury or overheating, as described farther on.

At the same time I should like to call attention to the fact that all corrosion (oxidation) can be prevented absolutely by annealing in a sealed furnace charged with illuminating or other proper and convenient gas.*

It is reserved for one of our progressive bridge builders to introduce a non-oxidizing annealing furnace and then use a high steel and anneal all members in case the material has been punched and not drilled.

The method adopted for annealing full sized eyebars and built-up members, and by which most test pieces were treated was the following: The furnace about 55 ft. long, was brought to a high heat by a soft coal fire at one end, the flames from which passed through channels and ports into the heating chamber, which had two compartments, separated by a brick wall, and each closed by a cast iron door, which ports and doors could be sealed thoroughly to prevent entrance of gas or flame when desired, or cold air from the outside. Upon reaching a yellow heat the chamber door was opened after the ports had been closed, the pieces to be annealed were rolled in on cast iron trucks, and the doors again closed and sealed with wet clay. After several hours' exposure to the radiated heat of the chamber walls the material reached a copper color heat, and the trucks with the material were again withdrawn and allowed to cool. All fire being excluded from the chamber while the material was under treatment, there could be no overheating or burning, and all material was sure to be treated exactly alike. Before this method was adopted the most disastrous results had sometimes been obtained in more instances and places than one, and by several works and engineers annealing was declared impracticable, unsatisfactory and injurious to the material. It may here be recorded that one of our largest bridge works tried to anneal eyebars by burying them in a great pile of wood and shavings, setting the whole afire, and keeping it burning for some time, after which the ashes were supposed to anneal the metal!

Another prominent works started a roaring soft coal fire in a brick annealing furnace, and, after attaining a high heat, placing the material to be treated in it; then firing anew, so that the material was surrounded by flame, smoke, and unconsumed gases until it had reached an almost white heat, or at least a bright yellow, after which the fire was allowed to die out, and furnace material cooled off in three days' time until they could be handled. What would a metallurgist say about such treatment of steel as this?

To test the effect of the annealing process the material was subjected to chemical analysis, and to physical tests before and after annealing. The analyses showed nothing of importance except the discrepancy between the steel works' analyses and those made by an outside chemist, noted above. The physical tests showed quite diverse changes in the material. The following table summarizes the effect of annealing on bars:

	No. cases raised.	Average amount raised, lbs. per sq. in.	No. cases lowered.	Average amount lowered, lbs. per sq. in.
Elastic limit	33	4,570	9	2,000
Yield point	39	3,100	5	2,540
Ultimate strength	17	1,972	26	3,183
Modulus of elasticity	30	991,200	8	1,173,000
		per cent.		per cent.
Elongation	24	3.41	15	1.50
		Units.		Units.
Prop'tional resilience	27	198	26	108

The author distinguishes between yield point (which corresponds to elastic limit as ordinarily determined by drop of beam) and elastic limit, which he determines by plotting micrometer measurements of elastic curve. Proportional resilience is a quantity obtained by multiplying the ultimate strength by the percentage of elongation.

The seeming incongruity in the results of the tests is explained by the author on the ground that part of the specimens were treated in a coke furnace instead of in the annealing furnace above described. He holds it well proved that proper annealing of this grade of steel, while it reduces the elastic limit and ultimate strength, increases the modulus of elasticity and the percentage of elongation in greater ratio and makes the steel actually capable of resisting a greater shock, hence more valuable for actual use. In annealing, however, the material should not be heated above a copper color. If heated to a high temperature, the elastic limit, tenacity and modulus of elasticity are all lowered.

The author thinks that ordinarily methods of testing are quite unsatisfactory to determine the most essential characteristics of materials and favors the use of autographic registering devices which will magnify considerably the elongation of the specimen.

* See "A Non-Oxidizing Method of Annealing," Eng. News, Jan. 2, 1892.

A CONVENIENT WHEEL-BASE MOMENT DIAGRAM.

As our readers well know, we do not feel any large amount of interest nor confidence in computations of bridge strains from individual wheel loads. After the static strains from the loading are all computed, by whatsoever method they are computed, they do not come within a hundred or two per cent. of the strains to which the structure is actually exposed in practice when actual trains go thundering over it, especially if the train happens to get off the track at just the wrong moment.

Still, the existing conditions in bridge construction and in bridge competitions make the use of this method imperative in many cases, whether the engineer believes in it or not; besides which it is not our place to attempt to impose our views on this or any other like question on engineers who see the question in a different light. But if any one wants to compute strains from the individual wheel loads, for whatever reason, he wants the easiest way for doing

it he can get; and perhaps the method exemplified in the accompanying diagram, for which we are indebted to Mr. C. A. P. Turner, C. E., of Wilmington, Del., will be found useful to this end.

Mr. Turner himself expresses his doubts as to the wisdom of this method of computing bridge strains, in sending us the diagram, in the following words:

The writer is not inclined to favor typical locomotive loading, but while it is called for by most railway specifications bridge companies will be forced to use it, and in the sharp competition of to-day they will continue to prefer exact methods.

'Tis even so, and we do not blame them for it, despite the fact that it does no real good, but only harm. Mr. Turner's description of the diagram is as follows:

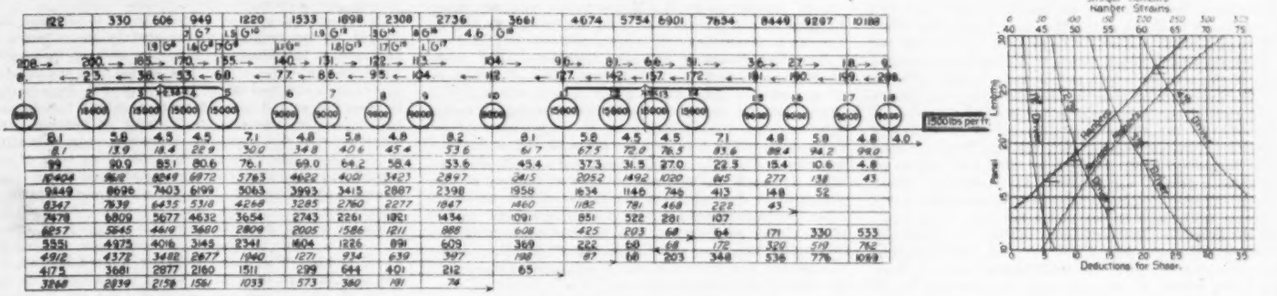


DIAGRAM FOR COMPUTING BRIDGE STRAINS FROM WHEEL LOADS

In the diagram the first line is a black moment tabulation. The second and third lines give the positions of the centers of gravity of different combinations of wheels. For instance, G-5 is the center of gravity of the first five wheel loads, and so on. The fourth and fifth lines give the sums of the wheel loads at each respective wheel, taken from the right and left, respectively. The first line below the wheel loads gives their distances apart, and the second and third lines below them give their distances from either end. The remaining lines are the moment tabulations from each wheel of the second engine. At the right is a small diagram on which is plotted a curve of (1) hanger strains, (2) stringer moments, and (3) curves giving the reactions of the wheels which have passed the panel point at the next panel; which strains are to be deducted from the reaction to find the exact shear in that panel. The panel lengths are tabulated vertically upon the left of the diagram. The scale for the deductions for shear is given at the bottom of the diagram in thousands of pounds, and the scale for hanger strains and stringer moments at the top. The stringer moments are given in thousands of foot pounds, the same as the wheel moment tabulation.

The curve of hanger strains is a broken curve, composed of segments of six different hyperbolas, varying so little from a straight line that it could be replaced by one with a maximum error of but about 500 lbs.

The curves of deductions for shear are also hyperbolas of form of $xy = c$. with O—O as origin until in fulfilling the condition of (l-nth) of the live load upon the panel (using Professor Merriman's notation) the first wheel passes off of that panel; when we have a new curve, also a hyperbola.

DESULPHURATION OF PIG IRON BY MANGANESE.

The following interesting particulars in regard to this process are taken from a report by Mr. F. H. Mason, U. S. Consul-General at Frankfort, Germany. It is stated that very satisfactory results have been obtained at the Hoerde works in Germany, which is the plant referred to in the report, and that other plants for the operation of this process are now being erected at some of the largest iron establishments in Europe:

At a meeting of the Iron and Steel Institute in London, in 1891, there was presented by Mr. J. Masenez, a German engineer, a report describing concisely the results which have been attained in desulphurating raw iron direct from the blast furnace by treatment with manganese at the works at the Hoerde Mining & Furnace Co., near Dortmund, in Germany.

The process is based on the well known chemical affinity between sulphur and manganese when both are in a fluid condition. This affinity was demonstrated more than 30 years ago through analyses of manganic slags at the mining school in Loeben, and it has since been utilized to some extent at certain furnaces in the Austrian provinces of Styria and Carinthia.

But it remained for the managers of the furnace company at Hoerde, in Westphalia, to reduce the application of this principle to a system so simple, cheap and effective that it accomplishes at a trifling cost not only the desulphuration of the pig iron to the point of readiness for immediate conversion into steel by the Bessemer process, but secures for the iron thus treated a valuable uniformity of texture in respect to its admixture of silicon, phosphorus, and manganese, and finally leads to an important saving in fuel and fluxing material by enabling the blast furnace to be worked at lower temperatures than have been hitherto consistent with good practice when working sulphurous ores or coke. The process itself is a development of the well known "mixing operation," which is already practiced to some extent in Great Britain and the United States. Its theory is concisely stated in the proposition of the Hoerde company, submitted to the patent bureau at Berlin:

(1) When sulphide of iron is melted together with ferromanganese, or when molten sulphide of iron is mixed with molten ferromanganese, the sulphur unites with the manganese, forming a scoria of sulphide of manganese, leaving the iron practically free from sulphur. The same result follows when molten sulphurous iron is mixed with molten manganiferous iron. Experiment has shown that raw iron containing as high as 3 or 4 per cent. of sulphur retains, after proper treatment with manganese, not more than 0.13 per cent. of sulphur, while the resulting scoria may contain as high as 20 per cent. of sulphur and 30 per cent. of manganese.

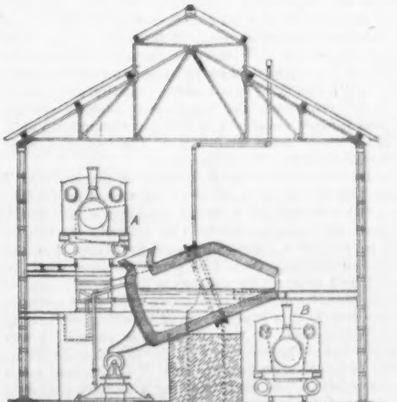
(2) When this scoria is mixed with a basic earth, notably limestone, and the mixture reduced by melting, the sulphur forsakes the manganese and unites with the lime, leaving the manganese restored to its original purity and capable of being again used for purifying iron from sulphur.

In practice this theory, as will be hereinafter shown, has been simplified in some important respects at the works in Hoerde and the cost of its application thereby greatly reduced. The ores used by that company are various in character and origin, the principal ones being Luxembourg "minette," 40 to 42 per cent. of iron; native black-band ores, about 50 per cent. of iron; puddle slags from England, Belgium, Westphalia and the Saarbruck region, which contains from 54 to 56 per cent. of iron, with from 2 to 4 per cent. of phosphorus in the form of phosphoric acid; pyrites and other waste material from the soda and acid factories; and, finally, the Nassau manganic brown ironstone, containing some iron and from 8 to 12 per cent. of manganese. These ores are mixed in such working proportions that the pig iron, when it comes from the blast furnace, shall contain from 1.5 to 1.7 per cent. of manganese, which has been found sufficient to effect a thorough desulphuration of the iron.

The works at Hoerde comprise three sections or departments, which are located contiguously and connected by railway tracks, viz.: a group of four blast furnaces with blowing apparatus, the desulphurating plant, and the Bessemer basic steel works. Of these three sections the first and third present no peculiarity. It is the desulphurating process with which we are at present concerned. In a separate building of cheap construction, located midway between the furnaces and steel works, the desulphurating apparatus is established. Its general construction is roughly indicated by the drawing.

Upon a strong foundation of masonry is mounted the iron reservoir, or "mixer," of either the "Bessemer-Birne" or the "Johns" pattern—without tuyeres in the bottom—which has a capacity of 70 tons of molten iron, though a larger form, capable of holding 100 or 150 tons, is recommended as in all respects preferable. The mixer is lined with two layers of fire brick, similar in nature to those used in blast furnaces, and is hung on trunnions, so that the vessel may be readily decanted by hydraulic power.

When the blast furnace is tapped, the iron is run into large ladles, each having a capacity of 10 to 11 tons of metal, and is mounted on a strong railway truck, to which is attached, when used, a small locomotive of the simplest pattern. The ladle, thus mounted and filled, is run along the rails to the point (A) in the desulphurating house, where its contents are poured into the mixer. This process is repeated until the latter is filled. As the molten iron in the mixing vessel gradually cools, there rises to the surface a scum of dark scoria covered with bubbles. This is the sulphide of manganese formed by the reaction of the manganese and sulphur in the iron. In 20 minutes after the last ladleful has been poured into the mixer the desulphuration is complete, and thenceforward the operation is kept up throughout the week, pouring into the top of the mixing vessel charge after charge of sulphurous iron from the blast furnace and drawing out desulphurated iron from the nozzle at the other end. The railway ladles are hung upon trunnions, and are easily decanted by a geared windlass operated by two men. Having thus discharged its load of sulphurous iron into the mixer, the ladle is run down a short incline and switched by another track to the point (B) under the nozzle of the vessel. This is then decanted by hydraulic power, the ladle is filled with desulphurated metal covered with floating sulphide of manganese, and is then run along the rails to the steel works, where the ladleful forms a charge for the converter. The heat created or liberated by the reaction of the sulphur and manganese in the mixer is sufficient to keep the molten bath fluid for a long time, and thus there is available for the converters a constant, elastic supply of metal in condition to be blown into steel,



Apparatus for Desulphurating Pig Iron

independent of the exigencies which may govern the tappings of the furnaces. When several blast furnaces are thus worked together and one or more of them is running badly, this independence of action between furnaces and converters is often of great importance.

Theoretically, it was proposed that the manganic slag should be removed from the surface of the molten mass while in the mixer; but it has been found in practice that while there it is too hot and liquid to be conveniently managed, so it is left to cool during the final transfer from the mixer to the steel works and is removed from the surface of the ladle charge with a large perforated skimmer just before it is poured into the converter. In case any accident at the steel works should require the bath to be retained a long time in

the mixing vessel without the addition of any fresh hot iron from the furnace, a few sticks of wood thrown in will create a blaze that prevents too rapid cooling; but this recourse is only for emergencies and has no part in ordinary practice, the heat generated by the reaction already mentioned being fully adequate for the purpose. In fact, the gradual cooling of the contents of the mixer is an important element in the process.

Thus the operation goes on at Hoerde, the mixer being entirely emptied each Saturday night, and, if necessary for the repair of its lining, it is cooled by injecting water therein, and the repairs made in time for the resumption of work on Monday. This violent cooling of the vessel is, of course, injurious to the lining, and, as such repairs are necessary once in three or four weeks, it is a great, and in the end an economical, convenience to have two mixing reservoirs mounted side by side, so that one may be slowly cooled by natural means while the other is in use. It is only the inner layer of fire brick which is attached around that part of the interior which comes most in contact with the floating scum of manganic sulphide, so that only a small part of the lining usually needs to be renewed.

The cost of the whole desulphurating plant, including building, hydraulic power, etc., for one 100-ton mixer is, in Germany, about $12,000, or with two mixers of the same capacity, say $16,000. At Barrow, in Great Britain, where the mixing process is employed in order to secure uniformity in the metal for direct steel-making, Sir Lowthian Bell estimates the cost of using the mixer at not more than 2 cts. per ton, while melting cold pig iron in a cupola for steel making costs, in fuel and labor, about 60 cts. per ton. The process is, of course, equally applicable to making iron in ordinary pigs, the only difference being that, instead of being hauled in railway ladles from the mixer to the steel works, the desulphureted iron is run directly into the sand bed of the casting house.

It remains to state, collectively, the advantages that are gained by this process. The first is the desulphuration of the metal. Sulphur in raw iron may result from the presence of crude sulphur in either the ores or the fuel used in smelting, or in both. A comparatively slight admixture of sulphur is often sufficient to render the iron unsafe for direct steel making by the Bessemer process. And, as sulphur unites with the iron most readily at low temperatures, it is necessary, in order to expel it, to work the furnace at a very high temperature, which not only consumes additional fuel and fluxing material, but burns out the furnace lining more rapidly and in the end turns out iron too hot for the best results in direct steel making.

It enables furnacemen to use sulphurous ores and cheap waste materials, such as pyrites, etc., without regard to the percentage of sulphur that they may contain. As much of the coke now used in Germany contains as high as 1.8 per cent. of sulphur—enough in itself to compromise the purity of the iron—this latter is a point of great practical importance. In respect, therefore, to the quality of ores and the quantity of coke and limestone consumed, the manganese process enables German furnace managers to exercise economies which, in the present close condition of the iron and steel market, are of decisive importance.

Not less valuable is the uniformity of texture that is secured in the whole mass of metal turned out, either to be run into pigs or blown at once into steel. Every practical furnaceman knows the difficulty—rather, it may be said, the impossibility—of providing that the successive charges from the same furnace shall be normal and uniform in respect to the percentages of silicon, phosphorus, and manganese that they contain. Particularly is this true in regard to silicon in iron to be used for steel. If the silicon is in excess, it will blow too hot in the converter; if the silicon is deficient, it will blow too cool, and the results of this and other irregularities in the iron leads to a serious waste in the form of defective rails. The difficulty is even increased when several furnaces are worked together for direct steel making; frequently one furnace will be running badly while the others are running well, and thus a serious disparity in the product is inevitable. Against these difficulties the mixing together of a large mass of raw iron of varying qualities in a reservoir outside the furnaces offers so effective a remedy that even in some large establishments where no trouble is experienced with sulphur the mixer is now regularly used in order to secure the desired uniformity.

Theoretically, the process involves the use of ferromanganese; but, as this is a somewhat expensive material, the company at Hoerde effects an important economy by using the manganiferous brown iron ores from Nassau, which are not only plenty and relatively cheap, but readily furnish the very small percentage of manganese that is requisite for desulphuration. I am informed by Mr. Massenez that it is even quite practicable, when working three blast furnaces together, to use the manganiferous ore in only one of them, but in such proportion as to provide sufficient manganese in the mixed product of all three when brought together in the reservoir. This saves labor and care in mixing the ores for two of the furnaces, and thus another small economy is effected. The proportion of manganese required to effect desulphuration is so small that its use as an ingredient would in any country add but little to the aggregate expense account. For the reasons above stated, no use is made at Hoerde of their process for purifying the slag from the sulphur in order to recover the manganese to be used over again in the desulphureting operation. This might be done with advantage in a country where no manganiferous ores exist and where ferromanganese is costly or difficult to obtain, but no such necessity prevails in Germany.

Plants for the utilization of the manganese process are now being erected at some of the largest establishments in France, Belgium, England, Austria and Germany. Among others, the Krupp works, at Essen, have adopted it, and one furnace company in Austria is putting up a mixer that will contain 200 tons of metal.

From the abundant analyses that have been made at Hoerde to test and demonstrate the effectiveness of this process, the following figures are quoted in Mr. Massenez's report. They show the analyses of seven sample charges, each taken at a certain hour of as many consecutive days, so that the table represents the average run of the establishment for a week and exhibits for each day the percentages of sulphur in the raw iron as it came from the furnaces and the same after treatment in the mixer, thus showing the degree to which the sulphuration was reduced, as well as the uniformity that was secured in respect to phosphorus, manganese and silicon in the desulphurated iron. All the figures are percentages:

	Sulphur in iron from blast	After treatment in the mixer.			
Charge	furnace.	Sulphur.	Phosphorus	Manganese.	Silicon.
First.....	0.216	0.053	2.82	1.53	0.13
Second.....	0.135	0.036	2.74	2.07	0.28
Third.....	0.348	0.051	2.88	1.96	0.21
Fourth.....	0.265	0.035	2.86	1.25	0.28
Fifth.....	0.481	0.078	2.87	1.36	0.17
Sixth.....	0.176	0.086	2.74	1.31	0.23
Seventh.....	0.147	0.074	2.91	1.15	0.13

The analysis of an average sample of the scoria, or magnetic slag, produced at Hoerde by this process, gave the following results:

Components.	Per cent.
Manganese sulphide	17.07
Manganese oxide	20.23
Ferrous oxide	25.46
Silica	18.9
Alumina	5.00
Lime	3.53
Magnesia	0.43

The recent discussion at London and the prominence which has been given to this subject in the leading technical journals on the continent combine to show that the manganese process as at present perfected marks an important epoch in the history of iron and steel manufacture.

NOTES ON A PROBLEM IN WATER POWER.

In the Eastern states, as is well known, the type of water-wheel in practically universal use is the turbine. On the Pacific coast the turbine is replaced by the Pelton wheel, driven by a tangential jet of water, with results which are now pretty widely known. There is still, however, a prevalent idea that the Pelton wheel can compete with the turbine only under very high heads; and from its simplicity and its general use in mining and mountain districts the impression may still exist that it is a rough and uneconomical motor. In a description of the Pelton wheel in our issue of Feb. 20 we reported tests showing an efficiency of 80 to 87.5%, and we believe 90% has been frequently obtained.

At the recent meeting of the American Society of Mechanical Engineers, Mr. John Richards, of San Francisco, President of the Technical Society of the Pacific Coast, presented a paper with the title given above, in which he called attention to the remarkable efficiency of the impulse wheel as compared with the turbine, and propounded the question, why has the "pressure" type of water motors been developed to the almost total exclusion of the impulse type everywhere save on the Pacific coast? We give the substance of his paper as follows, and would call especial attention to his query as to the relative merits of turbines and impulse wheels for the Niagara Falls power plant:

Water wheels, as we have to deal with them, may be classed as gravity wheels, including (1) overshot breast wheels and perhaps the Poncelet types; (2) pressure wheels, including what we call inclosed turbines and reaction wheels; (3) impulse wheels, driven by spouting water.

In modern practice the class called pressure turbine wheels constitute perhaps four-fifths of the whole. These can be divided into three general types, namely: The Fourneyron, or outward radial discharge; the Jonval, or downward discharge parallel to the axis of rotation; and the American, or inward flow wheels. These have come into general use all over the world, and have a literature of surprising completeness. They are by common consent regarded as the most efficient and, indeed, until recently, have been the only wheels which were considered in connection with an efficiency beyond 60%.

The construction of the turbine or pressure type of wheel involves closed vessels, or conduits, not only to the water wheels, as in other cases, but around them. They must be enveloped in the fluid that drives them, and contained in cases strong enough to sustain not only the static head, but also the effect of water concussion, and in most cases to afford support for the wheels themselves and their shafts.

The bearings of the wheels have to sustain the weight of the running parts, also in many cases a pressure of the head, equal to the area of the issues multiplied into the head. The wheels are submerged, placed at the bottom of the head or near it, inaccessible to observation, and also for repairs, calling for unusual and expensive provision in the way of bearings and other constructive features, including extra strength of all parts. The hydrodynamic conditions both of entrance and discharge call for complicated forms that cannot with safety be built up, and pressure turbine wheels thus become large and expensive castings, the value of which depends upon the integrity of every part. If a vane be broken or imperfect, the whole wheel is lost. The diameter being limited because of first cost, a limit of rotative speed is reached at heads of 50 ft. or so, and even at that head the bearings have to run under undesirable conditions; in other words, this type of wheels does not permit control of rotative speed, that being limited by both first cost and operating conditions.

Turning now to the other type of wheels, but little known in this country except on the Pacific coast, the impulse class, and assuming that the force of spouting water is equal to its gravity less an inconsiderable friction in orifices, the question arises, why has not the evolution of water wheels followed on this line instead of pressure for all except low heads?

This is a very important question, one that may well engage the attention of this society, and one that calls for explanation such as will be by no means easy or apparent. It is true that with that class of impulse wheels called "undershot," and some other crude forms operating by the impulse of spouting water, the efficiency attained has been so low as to lead to the conclusion that the losses were inherent in the method, or mode of operation, and this opinion has, it seems, become general without anyone very closely inquiring into the matter.

That the efficiency of tangential wheels driven by impulse is as high as can be attained by pressure turbines has been proved by numerous experiments here, also by some recent tests at Holyoke, Mass., and is beyond controversy. It has long been settled on this coast, and as a problem no longer exists. No one here would expect under a head of 50 ft. or more to attain with any known type of pressure water wheels a higher efficiency than is given out by tangential impulse wheels; but this state of opinion and practice is confined to narrow limits now, and is the more to be wondered at when we consider the rapidity and completeness of investigation in other branches of dynamic engineering at the present day, especially when the economic and constructive conditions so much in favor of the impulse type of water wheels are taken into account. These we will now consider in a brief way.

There is a wide difference between a water wheel driven by impulse and one operating on the pressure system. The first cost of the former, for a given power, is one-half as much, and its maintenance is still less, in proportion.

Figuratively speaking, when a wheel is changed from the pressure to the impulse system it is taken out of its case, mounted in the open air, in plain sight. All the various inlet fittings are dispensed with and are replaced by a plain nozzle and stop valve. Its diameter is made to produce the required rotative speed, whatever that may be. The shaft and its bearings are divested of all strains except those of gravity and the stress of propulsion when the water is applied at one side only. Most important of all, there are no running metallic joints to maintain against the escape of water, no friction and no leaks; there are, indeed, no running joints or bearings whatever, except the journals of the wheel shaft.

The effect of grit and sand is eliminated, both as to vanes and bearings, and there are no working conditions that involve risk or call for skill. If a vane is broken, another one is applied in a few minutes' time. If a large or small wheel is wanted, the change is inexpensive and does not disturb the foundations or connections.

Capacity is at complete control; the wheels can be of 10, 100 or 1,000 HP., without involving special

patterns. The speed of rotation is not confined to commercial dimensions because of patterns or other causes. It is merely a matter of choice with the purchaser or maker.

Now granting the efficiency of impulse wheels, which, as before remarked, can hardly be called in question for all heads exceeding 50 or even 30 ft., and conceding the constructive and operating advantages just pointed out, the question at first arises, why has the evolution of water wheels during 50 years past been confined to the pressure class? also, why has it been proposed at Niagara Falls to employ pressure turbine wheels under a head of 100 ft. or more, when the conditions point to the better adaptation of open, or impulse wheels? It is not necessary in such an inquiry to discuss the problem of horizontal and vertical axis, or other local conditions, in the case of the Niagara plant, or in any other case, further than to say that the pressure class of wheels offers no advantage not balanced by equal or greater disadvantages, as will no doubt appear if there should be discussion of this subject before the society. . . . . .

In this country, and it is a most commendable thing to mention, the pressure turbine by an inward flow, or an inward draft, has been greatly simplified in construction, cheapened in first cost, and at the same time better adapted to impure water, without losing anything in efficiency. I believe the inward flow turbines made by the Risdon Co. at Mount Holly, N. J., have in public tests on more than one occasion shown an efficiency as high as, or even higher, than the more finely fitted Fourneyron and Jonval types.

The record of American engineers in this branch is one of which they may well be proud; and now that impulse wheels of the Girard type have made much progress abroad, and have here in California been modified much as the Fourneyron and Jonval wheels have been in the Eastern states, it is quite time more attention was bestowed upon them in other parts of the country. The analogy in the two cases is marked. By an inward flow American makers reduced the running parts, or the wheel proper, of pressure turbines, to a small diameter, increasing its speed accordingly. This lessened the weight and cost of the wheels in the proportion of their diameters, and at the same time dispensed with the accurate fitting involved in the outward and downward flow turbines; and this, as before said, has been done without sacrificing efficiency.

The tangential type of open wheels has been similarly dealt with here in California. The running water joints have been wholly dispensed with. The construction has been cheapened one half. The round jet has been applied in the most simple manner, with an increased dynamic effect, and the efficiency attained is believed to be more than is reached by the finest examples of Girard wheels in Europe.

Conceding these statements and facts brings us back again to the query forming the subject of this communication, namely: Why has the evolution of water wheels followed on the line of pressure instead of impulse?

A PROPOSED RAPID TRANSIT SYSTEM FOR MONTREAL.

That circumstances alter cases is an axiom which engineers are taught by experience to appreciate far better than ordinary men. A system of water supply, for example, which gives the best of satisfaction in one community might prove a failure in another place where topographic or geologic conditions are different. So in the case of rapid transit, a system best for a new city might not be applicable to an old one, and a system applicable to a city where traffic moves back and forth in a narrow channel might not be a success in a city where the chief lines of travel radiate in all directions from a single center.

Montreal is peculiar among American cities in its climate, which in winter is far more severe than that of any other great city on this continent. The population of Montreal is 216,000, which is more than that of Detroit, Milwaukee, Newark, Louisville or Kansas City, and is exceeded only by 14 cities in the United States. The snowfall at Montreal is so great that keeping the streets or even the street car tracks clear of snow is out of the question. The only means of public conveyance other than hacks are the horse car lines, of which the city has 35 miles. The company has to provide "rolling stock" of three varieties to suit the conditions of the streets. Cars are used when the streets are free from snow, sleighs are run during the winter, and during the break-up in spring, when the sleighing is destroyed, but the slush is still too deep to make clearing the car tracks practicable, heavy omnibuses are used. The company's equipment includes 135 cars, 100 sleighs and 75 omnibuses.

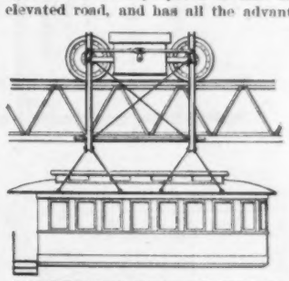
It is needless to say that for a city of the size of Montreal horse-car service is a slow and unsatisfactory method of transit. Yet the necessary abandonment of the tracks in winter has thus far kept the horse in service, for no other motor is available for both sleighing and wheeling.

Mr. Henry K. Wicksteed, M. Can. Soc. C. E., has given some attention to the transit problem in Montreal, and has designed a rapid transit electric system for the city, the principal features of which are made clear in the accompanying sketches. In a letter to us Mr. Wicksteed describes the difficulties in Montreal and his plans for meeting them as follows:

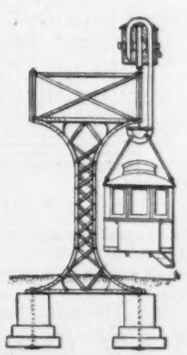
Montreal is probably worse off in the way of internal transit facilities than any other large city on this continent. Three different styles of vehicles are necessary to enable the horse car company to carry on its business in all conditions of the streets, and the wear and tear on horseflesh is tremendous. Besides this, the service is inadequate to the needs of the public.

On the other hand the distances are comparatively short, and it does not seem likely that an ordinary elevated railway could be a financial success for some years to come. The surface electric railway seems a delicate experiment on account of the depth of the snowfall. If the tracks are cleared and the balance of the street is left for sleighs, there would be a wide ditch 10 to 12 ins. deep along the center of the street, with barely enough room on either side for the sleighs to pass one another. To clear the whole street would be enormously expensive, and would practically ruin the business of the storekeepers on either side.

The compromise I have proposed is less expensive than the elevated road, and has all the advantages of



Side Elevation.



Proposed Sectional View of Rapid Transit Railway With Suspended Cars.

the surface road. It is intended to insulate the rail and carry the current through it, using the metal structure itself to complete the metallic circuit.

The system would be constructed as a circulating one, as proposed by Engineering News for the Brooklyn Bridge railway, the cars going along one side and back on the other, passing around a loop at the terminal. Transfers to branch lines could be made by means of turntables, a short section of the track swinging on a central column. The spans are intended to be from 40 ft. to 50 ft. in length.

While the cost of a structure with such spans would be much in excess of the cost of a single track surface road, its capacity is far greater. Compared with a well constructed double track road the difference in cost is not so great.

For a suburban or mineral road running on its own right of way, a double track line of great capacity can be built at very moderate cost by reducing the spans to 15 or 20 ft. This is especially true if the structure is built of timber.

Among the advantages of Mr. Wicksteed's design it is important to note that the supporting structure may justly be built with a much smaller factor of safety than an ordinary elevated railway, where the failure of the structure means the plunge of a train into the street, a fall almost certain to be attended by many fatalities. Should a structure of this sort fail, however, the car would have only a foot or two to drop to reach terra firma, and at the moderate speed at which cars in this system would have to move, such a fall would have very little danger for the passengers inside.

It is further pointed out that the use of large wheels in the truck would be perfectly practicable, and that by using a let-down step under the conductor's control the car could be made as accessible as an ordinary surface car and still be high enough above the ground to clear any ordinary obstacle. In the side elevation it will be noticed that the mode of suspension of the car is such as to cause some doubt of its safety to resist fore-and-aft motion, due to sudden application of the brakes or other cause. Doubtless this would be corrected in actual construction. We understand that a company has been organized with a view of carrying out Mr. Wicksteed's plans, provided a franchise can be secured from the city of Montreal.

STANDARD BUILDINGS ON THE MACON & BIRMINGHAM R. R.

(With inset.)

We are indebted to Mr. H. Tambs Lyche, late of the engineering staff of the Macon & Birmingham R. R. for drawings of the standard buildings along the line of that road, which has been built from Macon to La Grange, Ga., about 100 miles.

The depot building shown cost $1,300 complete. We believe seven were built. The usual separate waiting rooms for men and women are here replaced by separate rooms for white and colored passengers. The framing is light, permitting rapid and cheap construction; and the construction without masonry foundations and with only the waiting rooms and station masters' rooms on the first floor finished has much to do with its small cost.

On each track section is one 3-room and two 2-room houses, the former plastered inside, the latter without any inside finish. The total cost of the three houses on each section was $785, without paint. For the sake of variety, the usual custom of making all structures along the line of one standard design was discarded, and six different designs for these houses were made, some of the best of which are shown on our inset sheet. Naturally not many of the architectural graces are to be expected in a building costing hardly $200 and intended to shelter the family of a negro section-hand, who works for a dollar a day. It is really surprising, therefore, to see what attractive little houses the designer has produced. It is of course to be remembered that cheap lumber, cheap labor, and the lightness of construction made possible by a southern climate, go far to explain how so much has been done with so little money.

THE CAST IRON PIPE TRADE.

At a meeting of the Board of Trade of Reading, Pa., May 11, a paper on this subject was read by Mr. Peter D. Wanner, of which the following is an abstract:

The use of cast iron pipes grew out of the wants of water-works about the beginning of the present century. There were 16 of these works in the country prior to the year 1800, and 87 in the year 1850. Up to this time the pipe trade had developed slowly and was not regarded as of much importance. After 1850, however, the large and rapid increase of water and gas works made the demand for pipe proportionately large, giving new life and vigor to the industry, but the panic of 1857, as well as the civil war, retarded the trade very considerably. During the war only a few works of either gas or water were constructed, and it was not until after 1865 that the business again commenced to improve, and increased to such an extent that even the panic of the seventies did not appear to affect it until the year 1873. Owing probably to an overbuilding of water and gas works, and the high price of pig iron then ruling, the trade remained quiet until the summer of 1881, when it became very active, and remained large and profitable until the end of 1887. These were six years of unprecedented prosperity for the pipe manufacturers of this country, but with them disappeared the profits of the trade.

With net earnings for 1887 away up among the thousands, we had to be contented at the winding up of the following year with a few hundred dollars. Since then the best possible management was required to hold what had been previously accumulated and meet current charges, and should we take into account the wear and tear of machinery and fixtures, necessary repairs and improvements that should have been made, but were postponed, excepting only cases of absolute necessity, it would be entirely safe to say that no money has been made. Yet, during all this time the demand for pipe was large and the number of water and gas works were increased to an aggregate of 2,200 for water and 1,200 for gas, having probably not less than 50,000 miles of pipe.

The trade was also increased of late years by a demand from railways, etc., for pipe for sewer, drainage and culvert purposes, but owing to the great number of new pipe foundries constructed throughout the South and West, and the increased capacity of the older ones, the demand fell short of the supply. In other words, we have had overproduction.

All the new foundries built since the boom of the eighties could well have been spared and the money saved to the investors, but men learn by experience only. The present condition is full of anxiety and has brought about some very desperate movements, particularly on the part of Southern establishments. It is, in my opinion, absurd for iron industries in the South, no matter what their financial strength may be, to presume that they can either obtain or hold any great portion of the Northern trade. It is true they have closed up a number of furnaces and pipe foundries throughout the North, of which many will never run again, yet there are others which will meet every cut in price and remain in the trade. Having cut to cost and below, their next move must necessarily be on wages as a last resort. Some will plead, no doubt, for this Southern competition, that it results in cheap iron, pipe, etc., but when that can be reached only by the sacrifice or closing of our own works, or by a severe reduction in wages, we fail to see how it will promote either the interest, wealth or happiness of our people.

So far as the cast iron pipe trade of the future is concerned, I believe that each particular section will have its own works, or rather its own particular territory, to which their trade will become necessarily confined, and even in that event, each section will, probably, have to abandon some of its present works.

SCREW PILES IN GERMANY.

Where the Koenigsberg & Labiauer R. R. crosses the moat of the fortifications of Koenigsberg there is a small bridge of three 45.7-ft. spans, with the middle span resting on screw piles. The method of sinking these piles is thus described in the "Centralblatt der Bauverwaltung":

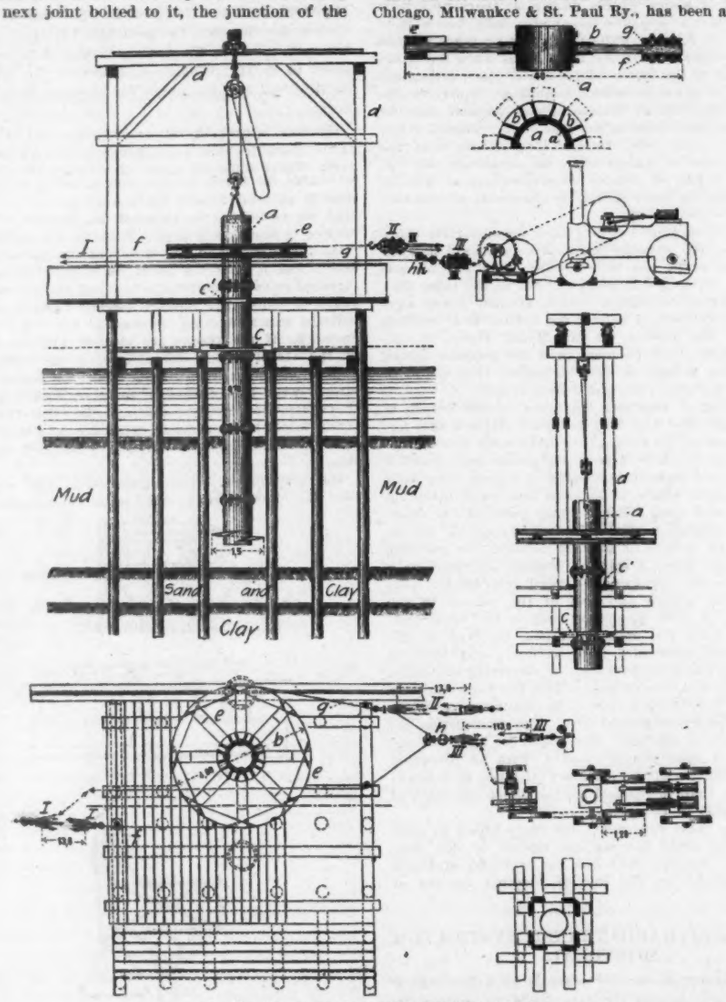
The piles were made of cast iron with an outside diameter of 2.56 ft., a thickness of 1.57 ins., and a length of 31.8 ft. They penetrated the soil for two-thirds of their length, and the sections making up the pile are bolted together with outside flanges with twelve 0.9-in. bolts at each joint. The lower section carrying the screw is 4.1 ft. long and weighs 3,500 lbs., while the remaining sections are each 6.56 ft. long and weigh 3,650 lbs. The screw makes 1 1-8 revolutions, has a diameter of 4.92 ft. and a pitch of 10.8 ins. The pile is finally capped by a finishing joint carrying one of the bed-plates for the bridge.

In order to apply the necessary power for sinking the pile, a head joint (a) was bolted to the top of the pile that was being sunk, and to this head a crown (b) was attached by four keys in such a manner that it could be raised as the pile was lowered. It was at first intended to insert eight bars, like capstan bars, in the holes in this crown and force the pile down by having four workmen push on each bar. For this purpose a light frame scaffold was built, as shown in Figs. 1 and 2. This scaffold was furnished with two guides (c) and (c') for insuring a proper sinking of the piles. Mounted on this scaffold was a frame (d) with a traveling differential block for adjusting the joints in position.

It was very soon found that the 32 workmen could not force the piles to any depth and some more efficient means had to be found. A portable engine and three tackles were employed in the manner shown in the cuts. A narrow drum (e) was attached to the head joint, and two ropes (f) and (g), wound about its grooves. These ropes were attached to the movable blocks in the tackles I and II, the free end of which were spliced together and run over a sheave (h) in the third tackle III.

The fall of this third tackle was carried to the drum of the portable engine, and in this way the necessary power could always be applied to the pile. It was calculated that the tension on the ropes leading to the drum was 2,320 lbs.

The operation of sinking a pile was conducted essentially as follows: The portion of the pile carrying the screw was blocked up on the scaffolding and the next joint bolted to it, the junction of the



PLANT USED IN SINKING SCREW PILES.

two pipes being made waterproof with hemp packing and red lead. On the top of the second joint the head was bolted, making a total weight of approximately 10,500 lbs., which was supported by chains from the differential pulley overhead. The pile was then lowered to the bed of the river and held in position by the guides (c), while the head joint was removed and a second intermediate joint was added. The head joint was again bolted in position and the crown, drum and guides (c') adjusted in place. The engine was then started up and the pile screwed down. After being sunk for approximately 6 1-2 ft. the head was removed and a third joint added. The perpendicular position of the pile was constantly maintained by the guides and occasionally by side bracing.

After every revolution the ropes (f) and (g) and the tackles had to be again brought into their original position, and after several revolutions the drum had to be raised on the head joint. While the preparations for sinking the next pile were being made the mud in the one just driven was removed and the interior filled with concrete.

PERSONALS.

Mr. W. C. Dawson has been elected City Engineer of Dayton, Ky.

Mr. A. B. Fitch has been appointed City Engineer of Terre Haute, Ind.

Mr. Horace Andrews has been reappointed City Engineer of Albany, N. Y.

Mr. Wm. F. Berry has been appointed General Traffic Manger of the Boston & Maine R. R.

Mr. John K. Lloyd has been appointed Superintendent of Construction of the water-works at Port Henry, N. Y.

Mr. C. P. Moore, Chief Engineer of the Chicago & New Orleans R. R., a new line, died at Farina, Ill., May 15.

Mr. E. M. Herr, Division Master Mechanic of the Chicago, Milwaukee & St. Paul Ry., has been appointed Superintendent of the new Grant Locomotive Works, at Chicago.

Mr. George M. Abell, Superintendent of Water-works, Dunkirk, N. Y., died May 17. He had held the position since 1880.

Mr. Elnathan Sweet, formerly State Engineer of New York, has been appointed a member of the new Water Commission at Albany, N. Y.

Mr. P. F. McDonald has been appointed Supervisor of the Durham Division of the Norforlk & Western R. R., with headquarters at Lynchburg, Va.

Mr. George W. Wadley, formerly Chief Engineer of the South Bound R. R., has been appointed General Superintendent of the Central R. R. of Georgia.

Mr. W. W. Finley, formerly Chairman of the Western Passenger Association, has been appointed General Traffic Manager of the Great Northern Ry., vice Mr. Shelby, resigned.

Col. C. A. Broadwater, of Helena, Mont., died May 24. He was largely interested in the construction of the Montana Central Ry., and was president of the company at the time of his death.

Mr. G. C. Cuñningham, City Engineer of Toronto, Ont., has resigned, and Mr. C. H. Rust, engineer in charge of sewers, has been temporarily appointed City Engineer pending further arrangements.

Mr. J. P. Suverkrop, Chief Engineer of the East Tennessee Land Co., at Harriman, Tenn., states that pressure of work requires his entire time and that therefore the Harriman Coal & Iron R. R. will hereafter be in charge of Mr. G. F. Simpson.

Mr. J. W. Kendrick, Chief Engineer of the Northern Pacific R. R., has also assumed charge of all engineering and construction matters connected with the Chicago & Northern Pacific R. R., Chicago & Calumet Terminal Ry., and Wisconsin Central lines (Northern Pacific R. R. Co., Lessee), with the title of Chief Engineer of the respective companies. The separate offices now maintained for these companies will be consolidated, and will be located at the Grand Central Station, Chicago.

Col. Walter W. DeLacy, an engineer of wide experience, died at Helena, Mont., May 13. He was born at Petersburg, Va., in 1819. He took a course of study in engineering at the Military Academy at West Point, and in 1839 was engaged on railway surveys in Illinois. In 1850 he was hydrographic engineer for the party under Capt. Barnard which made a survey for a railway line across the Isthmus of Tehuantepec, and in succeeding years, up to 1867, he was largely engaged on explorations and surveys in Montana, Washington and other parts of the Far West. In 1872 he surveyed a line along the Salmon River for the Union Pacific R. R. He was elected City Engineer of Helena, Mont., in 1883 and again in 1884, and was engaged in the office of the Surveyor-General until the time of his death. He was a member of the Montana Society of Civil Engineers.

NEW PUBLICATIONS.

A DICTIONARY OF ELECTRICAL WORDS, TERMS AND PHRASES.—By Edwin J. Houston, A. M., etc. Second edition: re-written and greatly enlarged. New York: W. J. Johnston Co., Ltd. 8vo., pp. 562; 570 illustrations. $5.

Advance sheets of the second edition of this dictionary have reached us. The book is a much more elaborate work than the first edition, which was published in 1889, and which has enjoyed an excellent standing. The new edition appears to be practically a new book, entirely rewritten and revised. The paper, engravings and type are all excellent. The definitions are given in two styles of type, the larger being used for the definitions proper, while the descriptive matter of a more general nature is given in a smaller type. Definitions are given under about 5,000 distinct titles and nearly as many more cross-references are given. We shall notice the work more fully when issued. We should judge that it would "fill a void."

MINES AND MINERALS OF WASHINGTON.—Second Annual Report of Geo. A. Bethune, State Geologist, 1891. Olympia, Wash. 8vo. pamph., pp. 187.

Washington is not generally thought of as a great mineral state, but rather for its wealth of land and timber; but this report shows in much detail how vast are the mineral resources alone of this corner of the splendid empire saved to the United States by the foresight and heroism of the missionary Whitman. Coal, iron, limestone, marble, and other building stones, gold, silver, copper and lead, all (except possibly copper) in great deposits of high grade ores, are found scattered over the state in great abundance. Nearly 2,000 men are even now employed in coal mining, and a much greater number in gold and silver mining, and yet some of the richest deposits are yet unworked, especially of silver-lead ores. Probably no part of the Union is now advancing more rapidly in population, or perhaps ever did advance, and certainly no state in the Union has been settled by a higher average class of men. It is destined, within a few short years, to be in truth an empire state; and those who take an interest in its progress, or would understand its cause, will find in this report much to interest them.

SOCIETY PROCEEDINGS.

ASSOCIATION OF CIVIL ENGINEERS OF VIRGINIA.—The next meeting will be held July 4 and 5, at Richmond, Va., with headquarters at Ford's Hotel. A trip is to be made down the James River. There will be an address by Mr. C. Coleman, the President, and the following papers will be presented: "Description of the Engines of the Battleship 'Texas,'" E. T. D. Myers, Jr.; "An Engine and Boiler Test," Prof. James H. Fitts; "Construction of Electric Dynamos," Prof. W. E. Anderson; "The Northerly Point," R. P. Crenshaw; "The Necessity of Co-operation of American Engineers," T. W. M. Draper; "A Plea for the Establishment of a United States Weather and Signal Station at Roanoke," Chas. S. Churchill; "A National Railway College," Herman Crueger; "Spiral Curves," Chas. H. Rice; and "River Improvements," Prof. D. C. Humphreys. J. R. Schick, Secy., Roanoke, Va.

LIVERPOOL ENGINEERING SOCIETY.—The annual meeting was held May 4. Mr. John T. Wood, President, in the chair. This meeting was numerously attended. Mr. Robert E. Johnston was elected President, and Messrs. H. P. Boulnois and Prof. H. S. Hele Shaw, Vice-Presidents. The adjourned discussion upon the paper read at the last meeting by Mr. H. P. Boulnois, entitled, "Refuse Destructors," was then opened by Mr. John Price, who stated that he had seen most of the refuse destructors in the country at work, and was very much in favor of their use. He agreed with Mr. Boulnois in considering that refuse destructors were in almost all cases the best and only means of getting rid of house refuse successfully. Mr. Maginnis criticised very freely the present method of dealing with ashpit refuse, which, he stated, is in most places very much behind the times. Mr. E. R. Window dealt principally with an improved method for the collection of ashpit refuse. Dr. Tatham, of Manchester, dealt with the subject as to how far destructors gave rise to a nuisance to the surrounding district.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The annual meeting was held in New York, May 17. The report of the Council showed the membership to be 615, a net increase of 74 over last year. The following officers were elected: Pres., Frank J. Sprague; Vice-Pres., A. E. Kennelly, Nikola Tesla, Oscar T. Crosby; Managers, Charles Wirt, Angus S. Hibbard, Dr. Michael I. Pupin, Charles P. Steinmetz; Treas., Geo. M. Phelps; Secy., Ralph W. Pope. The officers holding over from last year are as follows: Vice-Pres., Thos. D. Lockwood, Carl Hering, Wm. J. Hammer; Managers, J. C. Chamberlain, P. B. Delany, H. A. Foster, H. Ward Leonard, Dr. Louis Bell, Herbert Laws Webb, Prof. A. C. Compton and James Hamblet. The next general meeting will be held at Chicago, June 6, 7 and 8.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the annual convention to be held at the Hygeia Hotel, Old Point Comfort, Va., beginning on Wednesday, June 8, the following papers are announced as to be read: "Uniform Practice in Pile Driving," by J. Foster Crowell; "Rainfall, Flow of Streams and Storage," by Desmond FitzGerald; "Black Eagle Falls Dam," by M. T. Parker; "Hardening Structural Steel," by A. M. Cunningham; "Test of Full Sized Eye-Bars," by F. H. Lewis; (a), "The Cantilever Highway Bridge at Cincinnati," by Gustave Kaufman; (b), "The Cantilever Span of the Same," by F. C. Osborn; "Bridging Canyons Lengthwise," by H. V. Hinckley; "Experiments on Iron and Steel Joints," by B. P. Flint; "Railroad Emergencies," by Channing M. Bolton; "The Increasing Cost of Railway Tie Renewals," by Benjamin Reece; "Construction and Cost of the B. & O. R. Tunnel in Philadelphia," by W. W. Thayer; "Details of the New Government Pier at Old Point Comfort, Virginia," by John B. Dunckiee; and other papers to be announced later.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The eleventh annual convention of the association will be held at Holyoke, Mass., June 8, 9 and 10, at Hotel Hamilton. The following papers will be presented: "Description of the Water-Works of Franklin, N. H.," by Mr. F. L. Fuller, C. E., of Boston; "An Experiment and a Failure," by Mr. Geo. A. Stacy, Marlboro, Mass.; "Water Supply for Fire Purposes," Mr. J. C. Haskell, Lynn, Mass.; "The Arrangement of Fire Hydrants and Water Pipes for the Protection of a City Against Fire," by Mr. J. R. Freeman, C. E., Boston; "A Canal Siphon in Cambridge," by Mr. J. L. Harrington, Cambridge, Mass.; "Detecting a Waste of Water," by Mr. B. T. Cook, Woonsocket, R. I.; "The Venturi Water Meter," by Mr. R. A. Robertson, Jr., Providence, R. I.; "The Effect of Aeration on Water and Sewage," by Prof. T. M. Drown, Boston; "The Purification of Drinking Water by Sand Filtration: Its Theory, Practice and Results, with Especial Reference to American Needs and European Experience," (illustrated by stereopticon), by Prof. W. T. Sedgwick, Boston.

During the convention there will be brief discussions on other topics than those named above.

On Thursday afternoon, June 9, a drive will be given by the Deane Steam Pump Co., including a visit to the summit of Mt. Holyoke. Friday, June 10, will be devoted to a visit to the three reservoirs which supply Holyoke with water, and to several manufactories, all under the escort of the Holyoke Water Commissioners.

Reduced rates over several railways have been promised by the Boston Passenger Committee. The hotel charges for room and board will be $3 per day. Mr. H. T. Holden, Nashua, N. H., is President, and Mr. R. C. P. Coggeshall, New Bedford, Mass., Secretary of the association.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on May 18, Prof. Howe's paper on the "Maximum Stresses in Drawbridges," was read. The paper discussed the various loadings possible for drawbridges, under different conditions; then took up the case of a drawbridge of two equal spans acting as a continuous girder and subjected to equal panal concentrations. The panel points which should be loaded to produce the maximum moment or shear at any point, was found by the aid of a diagram having plotted on it curves giving position of zero moment, amount of moment at turntable support, and amount of end reaction, for a concentrated load at any point. Only four different loadings were found to be necessary, and knowing these, four corresponding equilibrium polygons were sufficient to determine the maximum positive and negative shears at each panel point. The web stresses were determined by taking from the diagram the end reactions due to the panel loads applied in each case, and with the combined reaction, compute the web stress as in a discontinuous space. For unequal concentrations, the best method would probably be to compute the moments and shears for each panel for each load and then distribute the concentrations as nearly as possible according to the magnitude of these moments and shears. For actual wheel loads the computation would be very complex. Instead of wheel loads, an assumed equivalent uniform load or a uniform load and an engine excess would give stresses nearly correct.

Prof. Johnson exhibited an apparatus designed by him and constructed by Maher & Co., St. Louis, for measuring the elongation or compression of test specimens while under stress. It consists of two collars fastened to the specimen by set screws, each carrying a graduated circle 4 ins. in diameter, over the face of which moves a balanced pointer. The pointer carries a small vernier and is attached to a spindle, in which is a friction roller measuring exactly ½-in. in circumference. The roller on one spindle is operated by an arm which is attached to the other collar, these arms being mounted symmetrically on opposite sides of the specimen. The apparatus reads with exactness to the nearest ten-thousandth of an inch, and registers elongations beyond the elastic limit as readily as it does those below that limit. Its operation is very satisfactory. Arthur Thacher, Secy.

THE INSTITUTION OF MECHANICAL ENGINEERS.

(From our London Correspondent.)

An ordinary general meeting of this Institution was held in London, May, 5, 6. There were three items in the program: the President's inaugural address; the Marine Engine Trials Research Committee's report on the trials of the steamship "Ville de Douvres;" and a paper by Lt.-Col. English, on "Condensation in Steam Engine Cylinders during Admission."

The new president of the Institution is Mr. William Anderson, D. C. L., F. R. S., who is one of the best known and ablest of the mechanical engineers of England. For very many years he was the senior partner in the firm of Easton & Anderson, of Erith, Kent, and in that capacity, had charge of some very heavy contracts, especially in hydraulic engineering. The firm was, and still is, noted for its scientific character, and also for the excellence of the work turned out from its shops. Whether these two factors militated against its commercial success or not, we do not know, but, at any rate, when the position of Director-General of Government Ordnance Factories became vacant, Dr. Anderson thought fit to accept the post upon its being offered to him. The position, no doubt, is one of the most exalted among the professional offices in the public service, but government appointments of this nature have such inadequate salaries attached to them that the head of a contracting firm of engineers, of the magnitude of the Erith works, could hardly accept the post without making a considerable pecuniary sacrifice. The appointment of a civilian to this position was an innovation which was much objected to, but which has turned out remarkably well.

The address first reviewed the position of the Institution of Mechanical Engineers, apparently called forth by some rather strained criticisms which had appeared in the pages of a technical journal on the status of the institution.

It was founded in 1847. There are not a great many now living who can remember its inception, but those who do, are aware that it practically owed its origin to a schism in the parent Institution of Civil Engineers. These things are not recorded, and are perhaps, on the whole, better forgotten; but there can be no harm now in alluding to them in brief, as the old soreness has quite passed away. Indeed, the "Mechanicals" are indebted to the hospitality of the "Civils" for a theatre in which to hold their meetings, and there is the most perfect good fellowship between them. The first home of the institution was Birmingham, then looked on as the one great center of the mechanical arts. Birmingham has not declined since, but mechanics have increased in other parts to so great an extent that it is no longer possible to fix on one spot as the center. For 30 years the Institution lived and prospered in the great Midland town, but in 1877 a bold step was taken. A migration was made to London, and the Institution at once passed from a provincial society to one of national importance. This was not done without protest. There was the strong local opposition of the Birmingham folk, who objected to having the town thus slighted by the infant which it had "raised;" but it was felt that these considerations, strong as they were, must give way if the Institution were to become national, and the metropolis of the kingdom was felt to be the only neutral ground. The manufacturing engineers of other centers would not travel to the Midlands as they would to London, so to London the Institution had to go in order to retain its supremacy, and rise superior to the rivalry of the numerous other provincial societies which were spring-

ing up in various parts of the country. In 1856, however, a second new departure was taken, the institution of peripatetic summer meetings, which did much to enlarge the sphere of influence of the Institution, as indeed, they do up to the present time.

The wisdom of the step taken was soon apparent. During the 30 years of its Midland existence the membership had reached to over 1,000; in the course of the 14 years following, another thousand had been added to the roll. The annual income of the last year in Birmingham was $17,750; now it is $35,200. The invested capital in 1877 was under $58,000; now, in spite of the expense of the removal, and the liberal expenditure on the research committees, the capital is nearly $110,000. Whether the Institution would have continued to grow to the same extent as a provincial society is a point which cannot, of course, be absolutely stated; but we may be sure that it would not have commanded the same influence and prestige that it now does.

Dr. Anderson then gave some particulars of a problem of the great practical importance to mechanical engineers, and of extraordinary theoretical interest as well, that, namely, of the nature and composition of steel, and indeed, of alloys generally. Since the year 1879 the Institution has been investigating this subject, but little practical advance was made, or comparatively little, considering the amount of work done and the eminence of those who were engaged in the investigation. Of late, however, new light has been thrown on the subject, especially since a good and easily used pyrometer has been at last devised by Le Chatelier, the eminent French physicist. (See Eng. News, Oct. 10, 1891.) This has enabled Roberts-Austen to carry his researches further than was thought possible a short time ago, and the Research Committee of the Institution on Alloys, of which Professor Roberts-Austen is Chairman, promises to result in a fund of valuable information to the engineer. The problem, however, Dr. Anderson points out, is excessively involved. It amounts to a consideration of the number of permutations or combinations possible among some ten variables, the relations of which to each other are also dependent, not only on actual temperature, but also on the rate of its changes and on the uniformity of these changes throughout the mass. In the first place it seems almost certain that pure iron, which is the basis of steel, is allotropic, and can exist in at least two forms, one of which is hard and the other soft. Carbon again also exists in steel in two forms: either in chemical union, or not merely in such union, but at the same time in the form of detached particles of carbon, suspended in the mass. There are other ingredients, minute quantities of which exert notable influence on the mechanical properties of the material, and these properties are further dependent on the degree and rapidity of heating, and also on the rate of cooling. Under these circumstances it is not to be wondered at that users and makers of steel find chemical analysis alone not an infallible index of the quality of steel in connection with its practical uses. Dr. Anderson thought—and his opinion is entitled to the highest respect—that Roberts-Austen's method of noting the rate of cooling by curves automatically traced, affords the best promise of placing in the hands of the mechanic a means of judging of the uniformity in composition of the material at any rate, and even, perhaps, of its actual chemical nature, so far as affects his wants. The thermo-electric autographic apparatus has the merit of being cheap, it occupies but little space, and above all, the results can be obtained in a few minutes.

The address then took up the subject of the use of petroleum for industrial purposes. Dr. Anderson gave a lucid explanation of Mendeleeff's theory that petroleum is formed perennially in the depths of the earth. Water penetrating to the region where the terrestrial heat is sufficient to keep metals and their carbides in a glowing state, gives rise to chemical reactions, which result in the formation of petroleum in a state of vapor. The vapor mostly becomes condensed, but some parts cannot be condensed, and remain as natural gas. This theory has received confirmation to this extent, that petroleum has been artificially produced in the laboratory by means which were devised to represent the alleged process of nature.

Professor Kennedy's report on the trials of the paddle steamer "Ville de Douvres," is the last of the Marine Engine Research Committee's trials. The paper, which is of considerable length, is a mass of facts and figures, which it would be difficult to condense, and even then, would be robbed of a great part of their value were they given without the diagrams. The whole series of trials made by this committee should be studied together, and it affords a valuable fund of information to the marine engineer. The total I. HP. on the "Ville de Douvres" trial was 2,977, the efficiency of the boiler was 66.1%, and of the engine 11.7%. It should be added that the machinery for vessels of this class is not designed to give high efficiencies, as the run across Channel is but a short one. The best figures on any of the committee's trials were those obtained with the steamship Iona, in which the boilers efficiency was 69.2%, and that of the engines was 17.1%; the combined efficiency of the whole machine being 11.8%. It is to be regretted that the committee did not have an opportunity of trying one of the ocean liners. The engines of the Ville de Douvres were the most powerful experimented upon.

The concluding paper of Col. English depends on two other papers by the same author, and however ingenious his theory and formulas may be, we have not been able to see how they could be applied with practical advantage.

The summer meeting of this Institution will be held this year at Portsmouth, in July.

AMERICAN WATER-WORKS ASSOCIATION.—(Continued from May 19.)—At the opening of the Wednesday afternoon session, the following were elected members: Active—W. d' H. Washington, New York; Alfred D. Cypher, Peekskill, N. Y.; Wm. D. Pollard, Pottsville, Pa. Associate members—Dr. S. L. West, Bound Brook, N. J.; Philip Ely, Bayonne, N. J.

There being no discussion of the last paper of the morning, "The Kansas City Case," a paper was read by Mr. S. E. Babcock, C. E., on "Protection of Exposed Pipes Crossing Bridges." The paper gave the results of some experiments to determine the best material for packing around exposed pipes to prevent freezing. It also described a protected pipe on a bridge at Little Falls, where waste wool, partially saturated with oil, is packed about the pipe. This paper was published in our issue of May 19, together with a section through the pipe. There are three pipes on bridges at Little Falls, one each of 10, 8, and 6 ins. diameter, the 8-in. pipe crossing being 214 ft. long.

In the discussion, Mr. C. B. Brush asked if there was not danger from spontaneous combustion when waste wool saturated with oil is used. Mr. Babcock feared nothing of the sort. The low temperature of the water, he thought, would prevent this. The temperature of the water in winter was not known by Mr. Babcock, but the thermometer goes very low at Little Falls.

Mr. C. N. Priddy said that at Leadville manure was packed about street mains and that service pipes were protected by a double boxing of wood, with an air space between.

Mr. L. G. Wagner stated that at Rome, Ga., pipe has been laid beneath the river, which he thought a better and cheaper plan. In reply to Mr. Wagner and others, Mr. Babcock said that his paper was designed to show what could be done when submerged crossings were impossible. At Little Falls, when the ice goes out, the river bottom is scoured by it, making submerged pipe impracticable. There are, however, three submerged crossings at Little Falls.

Mr. G. H. Benzenberg gave considerable information regarding river crossings, of which there are six, at Milwaukee, Wis. There was formerly at Milwaukee a 30-in. main carried over a river by means of a bridge 556 ft. long between abutments, the pipe being about 45 ft. above water. The pipe was inclosed by a concentric casing of matched boards, giving a 4-in. air space. The water in the pipe never froze, although the flow was sometimes very small, and the cold at Milwaukee severe.

The casing needing repairs and it being desired to lessen the load on the bridge, it was decided to lay the pipe 5 ft. beneath the river bed. Flexible joints were not used, a diver being employed to calk all submerged pipe at Milwaukee. The pipe is tested once a year.

Mr. L. H. Gardner asked how the tests are made. Mr. Benzenberg stated that a valve is placed at each end of the pipe. There is a manhole to give access to the pipe. The pipe is emptied and examinations for leaks are made. It is then filled and extra pressure added. By the means of pressure gages leaks, if any, can be detected.

In low water vessels sometimes run against the pipe. Last year there were two breaks in submerged mains. One of these leaks was not found for several months, although a diver made two or three attempts to locate it, extra pressure being applied in order to make the leak apparent. After some time the leak showed its location at the surface. It was found to be on the under side of the pipe, and had worn a considerable groove in the pipe at one of the joints. The pipe was repaired by means of two half sleeves, put together at the surface, run with lead and then sawed apart. In placing these sleeves a sheet of lead was inserted between the joints and the sleeves forced together. Extra pressure was applied to the pipe, and the caiker drove in lead until leaks were stopped.

A steamer once grounded on one of the submerged mains at Milwaukee and broke the pipe for 9 ft. of its length. This was repaired in a manner similar to that outlined above, at a cost of about $1,100. At this point the pipe could not have been put upon a bridge. There are from 55 to 80 lbs. of pressure on the mains at these crossings.

Mr. C. B. Brush said that the Hackensack Water Co., of Hoboken, uses Ward flexible joints for submerged crossings. It had not been the practice to inspect these crossings yearly. Consequently a failure recently occurred owing to scouring out of the river bottom beneath the pipe.

Mr. H. F. Dunham gave an account of laying a submerged 10-in. main, about 1,200 ft. long, on an uneven, rocky bottom in 6 or 7 ft. of swift water. The pipe was anchored by bolts driven in the rock and riprap was placed about it.

Mr. C. N. Priddy stated that at Leadville all mains are tested from two to four times a year with a waterphone.

Mr. B. M. Espy said that at Wilkesbarre there had been for some time two 18-in. mains laid on the bed of a stream. Leaks had been found in each pipe. Last year a pipe was laid in a trench made by a dredge and covered afterward by the dredge.

Mr. W. A. Alexander said that at Wilkinsburg, Pa., there were six crossings by wrought iron pipe beneath the Allegheny River. Pipes are laid crossing and on top of each other by different companies.

A paper by Mr. Geo. W. Rafter, C. E., on "Some of the Circumstances Affecting the Quality of a Water Supply," was next read by the secretary. The paper considered his subject from the standpoint of natural history, giving as an illustration a tabulation of the microscopical life found in the Hemlock Lake water supply of Rochester. An abstract of this paper will appear in a later issue of this journal.

Prof. A. R. Leeds expressed his approbation of the paper, and referred approvingly to the studies of growths in the reservoir at Brookline, Mass., which are being made by Mr. F. F. Forbes.

The next paper, also read by the Secretary, was by Prof. W. P. Mason, and was entitled a "Case of Sulphuric Acid in a Water Supply." The paper first referred to the discharge into a stream feeding Mystic Pond, one of the sources of the water supply of Boston, of about 50 tons of sulphuric acid. This occurred about 1879. Between the point of contamination and Mystic Pond, about eight miles, there are several mill ponds. In these ponds the water showed acidity, but no trace remained when Mystic Pond was reached. This instance has often been cited to show how rapidly nature at times purifies polluted surface water, but Prof. Mason related an incident where the purification required over two years. In this case, by accident, the water of a 150,000-gallon pond or reservoir was polluted by several hundred carboys of sulphuric acid and for more than two years showed traces of acidity attributed to the pollution. A 450-000-gallon reservoir, 10 ft. lower and 60 to 70 ft. distant, not connected with the other reservoir, had its waters so impregnated with sulphuric acid which must have filtered through the shale and sand between that boilers supplied from the reservoir, were very badly corroded. The accident occurred Nov. 18, 1886. On Feb. 11, 1887, nearly three months later, Prof. Mason found 365 parts per 1,000,000 of sulphuric acid in the lower pond. The acidity, as above stated, continued for over two years.

The next paper was so lengthy that its reading was concluded Thursday morining, and it is therefore referred to below.

Thursday Morning.

At the opening of the session the Meter Register Co., of Chicago, was elected an associate member of the association.

Next came the continuation of the reading by Mr. C. Monjeau of a paper entitled "A Few Simple Suggestions as to Water and Water Supplies, Their Use and Abuse." The suggestions were good, but they were not few, for they took up about an hour on Wednesday afternoon and nearly as much the next morning. The writer urged the importance of pure water supplies for both man and beast, and especially for domestic animals, milch cows and creatures whose flesh is used for meat. He referred to the fact that typhoid fever and several other diseases are caused by polluted water. He said all surface water should be filtered and that all sewage should be purified. The old theory of the self-pollution of streams was referred to as a fallacy. Sewage should be excluded from streams, wells and all sources of water supply. Chemical examinations of water supplies should be made and these should be supplemented by biological examinations. Various statements made were fortified by quotations from noted scientists. In conclusion the association was urged to memorialize Congress, asking that it take steps to protect the water supplies of the country.

The paper gave rise to the most spirited discussion of the whole convention. This discussion was opened by Mr. B. M. Espy, the person who objected so strenuously to the paper of Mr. J. Nelson Tubbs regarding protection to municipalities in granting franchises. Mr. Espy said, in effect, that the paper found fault with, or condemned, water supplies throughout the land, and above all admitted the germ theory of disease. Medical science, he alleged, is divided on the

germ theory, but all the way through the article the theory was referred to as a settled one. The American Water-Works Association, Mr. Espy said, ought not to receive the paper, for if it did the paper would be used in case of typhoid fever epidemics in support of the germ theory. Mr. Espy referred to typhoid fever in Wilkes-Barre, which from his remarks was evidently attributed by some to the water supply, and said, in effect, that anyone representing a water company who had had experiences similar to his would object to the paper. In such questions as this water companies should keep neutral ground. The appearance of the article in the Proceedings of the Association might give trouble to corporations, and in order to save trouble and expense to the members the paper ought not to be published.

Mr. Espy having made a motion, which was seconded, to the effect that the paper be repressed, President Diven suggested that the question be referred to the Executive Committee.

Discussion brought out the fact that according to the rules of the association all papers had to be approved by the Executive Committee before admitted for reading before the association.

Mr. P. H. Lineen was against referring the paper, anyway, and Mr. P. D. Wanner had the same feeling. The latter thought that the ideas advanced in the paper were in the right direction. Truth must be met by town, county and state authorities. Some states are doing this. Pennsylvania takes measures to prevent the pollution of its streams, but Pennsylvania has no authority over streams that rise in New York. Congressional laws are needed. As to the germ theory, Mr. Wanner said, in effect, that when it strikes at health, money considerations and selfishness should be put aside.

There was further discussion by Messrs. A. N. Denman, J. H. Decker, L. H. Gardner, and others.

Except Mr. Espy no one seemed to object to the paper, aside from its length. The proposition to refer the paper to the Executive Committee was voted down by a rising vote. Mr. P. H. Lineen then spoke against propositions to exclude papers from the Proceedings just because they trod on someone's corns, and moved that Mr. Monjeau's paper have a place with the others. Mr. Monjeau asked leave to withdraw his paper, but cries of "no, no," silenced his request. Mr. Monjeau then stated that at the Chicago meeting of the association, only two years ago he presented the germ theory of disease and no one objected to it. A resolution to publish the paper was almost unanimously adopted.

Mr. A. Fteley, C. E., appeared before the convention at the request of the President, and gave a brief description of the new aqueduct and reservoirs for the water supply of New York. Most of the information has already been presented in this journal.

Mr. Fteley referred to the well known defective construction of a part of the new aqueduct, and said that it had been made good and that the aqueduct is now in perfect condition. The seven miles, virtually a siphon, at the lower end of the aqueduct, some of it under a pressure of 130 lbs., was an experiment, but has proved eminently successful. This section, of course, is in rock. Recent experiments had shown a leakage in this seven miles of only 350,000 gallons per day. (a)

The gate house at the head of the new aqueduct was characterized by Mr. Fteley as a three-way cock which cost $600,000.

The estimated daily capacity of the new aqueduct is 318,000,000 gallons. Recent calculations have shown that the coefficient of flow of the new aqueduct is about 94 or 95% of other good examples of masonry aqueducts. Whether this is due to the slight grade of the aqueduct, 7-10 ft. per mile, or the roughness of the interior, Mr. Fteley said remains to be seen.

The next paper was by Mr. C. B. Brush, its subject being "Gates on Force Mains." Mr. Brush described an accident which occurred May 3, 1892, in connection with the works of the Hackensack Water Co., of Hoboken, N. J. The two disks of the vertical gate in a 24-in. main had, through the breaking of the lugs connecting them with the stem, dropped suddenly, closing the main while under a pressure of over 100 lbs. per sq. in. Parts of the pump were broken and other interesting developments occurred, as described in Mr. Brush's paper, printed elsewhere in this issue.

A paper by Prof. A. L. Metz on the "Water Supply of New Orleans" was next read by the Secretary. There are three sources of supply: Rain water collected in cisterns, well and river water. The chief dependence of the city is upon river water. The rain water is generally stored in cisterns, having an average capacity of 2,000 gallons. The supply is likely to give out in dry spells and is always liable to contamination from the dust which collects on the roofs.

Recently the use of shallow or surface wells at New Orleans has been entirely stopped by the State Board of Health. Analyses of water from a 93-ft. well showed 1.27 parts of free and 5.2 parts of albuminoid ammonia per 100,000. Even the water from artesian wells at New Orleans is considered objectionable, especially unless their depth is great. Analyses have shown, the paper stated, that the river water, filtered or unfiltered, is the best to be had in New Orleans.

A volunteer paper on a "Combination System of Meter Rates" was read by Mr. J. P. Donahue. This paper will be referred to in a later issue. The system suggested was a uniform rate for a given quantity and a lower rate for all above that quantity.

In discussing Mr. Donahue's paper, Mr. P. D. Wanner said that the time would come when water meters would be as generally used as gas meters.

(a) The flow at the time of the experiments was not stated, but was probably at least 75,000,000 gallons.—Ed.

Thursday Afternoon.

The last paper on the program was by Mr. P. Milne. Mr. Milne said that the philosophy of a system of distribution is to preserve its dynamic energy as far as possible. This can be done: (1) By having a constant pressure from the reservoir or pumps. (2) By having a trunk main or mains equal in cross-section to the aggregate cross-section of the sub mains. (3) By keeping the size of the taps as low as is consistent with a reasonable discharge capacity in a reasonable length of time. If the taps are too large their draft on the supply when open will reduce the flow below a desirable velocity. By gaging pressures in different districts defects in old distribution systems may be detected and afterwards may be remedied.

Mr. H. F. Dunham read a volunteer paper descriptive of a covered reservoir at Coshocton, O., the covering being a dome 50 ft. in diameter. The cost per 1,000 gallons capacity was less than $13.

Mr. F. L. Fuller referred to a covered reservoir, designed by him, at Franklin, N. H. This reservoir was described and illustrated in Engineering News of May 12, 1892. It cost about $18 per 1,000 gallons.

In reply to a question from Mr. B. F. Jones, Mr. Fuller stated that covered reservoirs were recommended by the Massachusetts State Board of Health for surface water, in order to exclude light and prevent algae growths. This completed the reading of papers.

Every paper on the program was submitted by the person to whom the subject had been assigned and every one read. In addition the volunteer papers mentioned were read. Everyone who has attended similar conventions knows that this is an unusual record.

Prof. A. R. Leeds, Chairman of the Committee on "Vegetable and Animal Growths Affecting Water Supplies," reported progress. The committee believes that different tastes and odors of water are caused by the development of specific organisms.

It has been found that the character of water and the development of growths within it have a close relation. Sponges, for instance, develop best in running water, but most organisms develop most rapidly in stagnant water.

Mr. B. M. Espy asked if there are kinds of algae which are beneficial to water. Prof. Leeds could not answer affirmatively. Many aquatic plants are beneficial.

Prof. Leeds' committee was continued, with authority to cooperate with a similar committee of the American Society of Civil Engineers and the American Public Health Association.

At this point Mr. J. P. Donahue brought up the suggestion made by Mr. Monjeau in his paper that Congress be requested to legislate for the prevention of the pollution of water supplies. Mr. Donahue stated that in Wisconsin logs are sometimes stored for two or three years in large reservoirs and finally, with the water, let down the streams. This water, it was stated, pollutes the streams for long distances below. Health reports show that last year, after such pollution, the death rates of towns using such polluted water had an increased death-rate, while other towns on the same stream not using the water did not have an increased death-rate. Such pollution is an interstate matter and must be regulated, if at all, by Congress. Mr. B. F. Jones thought that Congress would consider that rivers must be used as sewers and thus would take no action. Therefore water must be purified. Mr. F. A. W. Davis urged that the association take action in the matter. He stated that the Indianapolis water supply is polluted by refuse from strawboard works, and that the owners hold that the city must take care of itself, and could not prevent the pollution.

It was finally voted that Mr. C. Monjeau, together with the incoming President and Secretary, should be added to the Committee on "Vegetable and Animal Growths Affecting Water Supplies" and prepare the memorial to Congress on the subject of the pollution of water supplies.

Mr. G. H. Benzenberg, C. E., brought up the question of a representation of the association in the Engineering Congress to be held at Chicago during the World's Columbian Exposition in 1893. Mr. Benzenberg was asked to formulate a plan for such representation.

The following were elected as officers of the association for the ensuing year: President, Mr. G. H. Benzenberg, C. E., Milwaukee, Wis.; Vice-Presidents, Messrs. J. P. Donahue, Davenport, Ia.; R. C. P. Coggeshall, New Bedford, Mass.; R. M. Clayton, C. E., Atlanta, Ga.; S. E. Babcock, C. E., Little Falls, N. Y.; W. H. Watts, El Paso, Tex.; Secretary and Treasurer, Mr. Peter Milne, C. E., New York; Finance Committee, Messrs. Wm. Ryle, Paterson, N. J.; Wm. Molis, Muscatine, Ia.; W. G. Richards, Atlanta, Ga.

It was voted to hold the next meeting at Milwaukee, Wis.

The Excursions.

Friday and Saturday were given up to all-day excursions, accompanied by the ladies. The excursion Friday was under the direction of the Local Committee, and the party visited parts of the Brooklyn water-works, including the Ridgewood pumping station and the Prospect Park reservoir. Other points of interest in Brooklyn were also visited and a fine lunch was taken at the Montauk Club, Brooklyn.

The excursion on Saturday consisted of an all-day's ride up the Hudson and in New York Bay, tendered by the National Meter Co., under the direction of its President, Mr. John C. Kelley.

The Saturday's excursion extended up the Hudson River some distance above Yonkers, then back down the river and through a part of the bay. Refreshments were served on the boat all the morning and about 2 o'clock the party landed in Brooklyn and proceeded to the new factory of the National Meter Co. where an elaborate lunch was served. Unfortunately the new factory is not in operation and thus the guests could not enjoy witnessing the 60 different operations necessary to make one of the styles of meter produced by the company.

The party, which numbered at least 300, reached New York about 5 o'clock. Although the day was rainy, it was thoroughly enjoyed, it being currently remarked at successive conventions that water-works men do not care for rain.

COMING TECHNICAL MEETINGS.

WESTERN SOCIETY OF ENGINEERS.
June 1. Secy., J. W. Weston, 230 La Salle St., Chicago.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 1. Secy., F. Collingwood, 127 East 23d St., New York.
June 8. Annual Convention. Old Point Comfort, Va.
ENGINEERS' CLUB OF ST. LOUIS.
June 1. Secy., Arthur Thacher, Odd Fellows' Building.
ENGINEERS' CLUB OF CINCINNATI.
June 2. Secy., J. F. Wilson.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
June 2. Secy., T. G. Pihlfeldt, 113 Adams St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
June 2. At Atlanta, Ga. Secy., F. A. Charlton, Macon, Ga.
NEW YORK RAILROAD CLUB.
June 2. At 12 W. 31st St. Secy., H. G. Prout, 73 Broadway.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
June 2. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' CLUB OF MINNEAPOLIS.
June 2. Public Library Bldg. Secy., F. W. Cappelen.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
June 3. Secy., E. K. Smoot, 603 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
June 3. Secy., O. von Geldern, 319 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
June 4. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
June 4. Union Station, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
June 4. 1122 Girard St. Secy., J. C. Trautwine.
WISCONSIN POLYTECHNIC SOCIETY.
June 6. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
June 6. Secy., C. L. Annan.
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 6, 7. Grand Pacific Hotel, Chicago. Secy., R. W. Pope New York.
NEW ENGLAND WATER-WORKS ASSOCIATION.
June 8, 9, 10. Holyoke, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
June 9. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
June 9. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
June 10. Union Station, St. Paul.
TECHNICAL SOCIETY OF NEW YORK.
June 11. 194 Third Ave. Secy., H. Schreiter.
ENGINEERS' CLUB OF KANSAS CITY.
June 13. Baird Building. Secy., Waterman Stone.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
June 14. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
June 14. Secy., C. S. Howe, Case Library Building.
NORTHWESTERN SOCIETY OF ENGINEERS.
June 14. Occidental Block, Seattle. Secy., E. H. Warner.
DENVER SOCIETY OF CIVIL ENGINEERS.
June 14. Secy., Geo. H. Angell, Jacobson Block.
BOSTON SOCIETY OF CIVIL ENGINEERS.
June 15. Secy., S. E. Tinkham, City Hall
MASTER CAR BUILDERS' ASSOCIATION.
June 15. Saratoga, N. Y. Secy., J. W. Cloud, Chicago, Ill.
MONTANA SOCIETY OF CIVIL ENGINEERS.
June 18. Secy., F. D. Jones, Helena.
AMERICAN RAILWAY MASTER MECHANICS' ASSOC'N.
June 20. Saratoga, N. Y. Secy., A. Sinclair, New York.
WESTERN RAILWAY CLUB.
June 21. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
June 21. Secy., R. N. Clark, Pittsburg, Pa.
AMERICAN INSTITUTE OF MINING ENGINEERS.
June 21. Plattsburg, N. Y. Secy., R. W. Raymond, New York.
CENTRAL RAILWAY CLUB OF BUFFALO.
June 23. Secy., Jas. Macbeth.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
July 4, 5. At Richmond. Secy., J. R. Schick, Roanoke, Va.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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VOL. XXVII. THURSDAY, MAY 26, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

SUBSCRIPTION RATES: one year, $5.00; 6 months $2.50; 4 months, $2.00; single copies, 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. Send both the old and the new addresses. No club rates allowed.

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

One of the greatest absurdities in our governmental practice is that of permitting, nay, compelling the "Supervising Architect of the Treasury Department," who draws the munificent salary of $4,000 per year, we believe, to design as well as to "supervise" the construction of several hundred buildings at once, which are under construction simultaneously in all parts of the country. At the present time there are nearly 300 such buildings in progress, the plans for all of which have been nominally evolved from the same brain, but really from his subordinate assistants and draftsmen. The greatest architect who ever lived could not do himself justice under such circumstances. He must perforce intrust most of the designing work and all of the superintendence to cheap assistants, and it is needless to say, considering the salary paid, that not even a great architect, still less the greatest one, has ever yet honored the position, nor is he likely to. The result is visible all over the country in some of the most "wooden" looking piles of costly stone work to be found in the civilized world. The worst of all, perhaps, is the largest of all, the New York Post Office. A grander site, a more magnificent opportunity no architect ever had. It is depressing to look out daily upon its dreary, dead monotony, as the editors of this journal have to do, and to remember that "the greatest architect since Michel Angelo" (as a great English architect has declared Richardson to be) was just rising into fame when it was built, and to think what he would have made of such a unique opportunity. It would have inspired him to outdo himself, and we should have had a building which would have been an honor to the city for centuries to come, and probably at less cost, for the present system is necessarily expensive as well as otherwise absurd. Every session of Congress from 40 to 80 new public buildings are authorized.

Under these conditions it is no reproach to the architect that his work is unsatisfactory. In fact, it is one of many evidences that our government gets an immense amount of honest, faithful service for very little money, that the results are no worse than they are. Moreover, the breath of scandal has hardly touched this office, where the opportunities for illicit gain are so great. But a change is plainly demanded. A bill has been prepared by the American Institute of Architects to remedy this pitiable state of things, and we are glad to learn that the prospect of its passing is good. As might be expected from its source, it is a very judicious one. It eschews the opposite folly of inviting all the world to compete for every building, as well as that of making one man design them all. For every public building not less than five architects are to be invited to compete by the Secretary of the Treasury, and they are to be paid for their designs, the successful competitor also superintending the construction. The office of "Supervising Architect" is still retained, but he becomes exactly what his name implies, and nothing more. In that field he will have his hands full, and have all and more than any one man ought to attend to. The present Supervising Architect is heartily in favor of the bill, we are glad to learn, and it should be passed without delay. The marked success at Chicago will help to convince Congress that the principle of selection is the true one for public as well as private buildings, and under the pending bill there is just enough of the competitive principle combined with it to eliminate all reasonable grounds of objection, and make it a proper permanent policy.

The report of the House Committee appointed to investigate the affairs of the World's Columbian Exposition, in view of the proposed appropriation by Congress, expresses entire confidence in the prospects of the exposition and points out anew how much greater and more important it will be than any previous notable international exposition. As shown by the figures given on another page, 76 foreign nations and colonies are expected to participate, 56 of which have already appropriated an aggregate amount of $3,783,900. In this country, 30 of our states and territories will make special exhibits and have already appropriated over $3,000,000. For the Centennial exposition of 1876 Congress made a loan of $1,500,000, on condition that it should be repaid before the stockholders were paid at the close of the exposition. For the Chicago exposition of 1893, Congress has been disinclined to make either a loan or an appropriation, but eventually a recommendation has been made to grant an appropriation of $3,000,000. Some measures of economy in the management have been suggested, but in the meantime the work of construction is being vigorously pushed. It is, however, proposed to postpone the dedication of the main buildings from Oct. 12 to Oct. 21, 1892. The financial estimate provides for a balance of $10,000,000, while the Paris exposition of 1889 had a balance or surplus of $2,000,000.

Since commenting on the Indianapolis cattle guard tests in our issue of May 12, our attention has been called to the fact that our comments were open to one interpretation which we by no means desired, and which would be highly unjust; namely, that we were placing upon an equal plane as evidence reports made and signed by three well known railway officials in charge of the test (Eng. News, Dec. 5, 1891), and a letter published Oct. 24, 1891, which (so far as the public was concerned) was anonymous, and the writer of which has since declined to make public his name to authenticate his statements, though he has been repeatedly requested to do so. We by no means desired or intended that any such interpretation should be possible. It would be highly unjust. If the matter is to rest where it is, if there are to be no further tests made, then one has only to look over the several articles which we have published (which can be traced complete by the references given) to see at once that the reports published in our issue of Dec. 5, 1891, and signed by Messrs. E. T. McConnell, F. G. Darlington and Wm. C. Cushing, should carry by far the greatest weight. Those gentlemen are all well known engineers holding responsible official positions, and are open to no rational suspicion of having had any other motive or intent than to observe and to declare correctly.

But the point is here. Every one who has ever had much to do with tests knows the immense difficulty of insuring conditions which shall be absolutely fair, of observing with accuracy what all the results really are, and of insuring that the apparent results are not merely accidental and liable to be reversed next time, but such as will follow at every trial. Therefore, every man who has a truly disinterested and scientific mental attitude, when he hears that any tests are disputed on questions of fact, does not stop to balance probabilities between the different witnesses, but says at once: "Give the disputants the benefit of a doubt. Let us wipe it all out, and try again. If the second results are the same, then assurance is doubly sure. If not, then we know that either the first tests were inaccurate, or that the results are indeterminate." This is also the proper attitude, when it is reasonably possible to repeat tests, because it is always possible that three well known men may be mistaken, and one unknown man who differs from them may be right. Especially is it the proper attitude when there is also a possibility that the conditions of the test were not just right; and when there has been also considerable change of conditions since the first tests were made, so that results which were correct under former conditions may be no longer applicable under present conditions, it appears to us is the only proper attitude. At any rate, that is the attitude of this journal. For all the above reasons we hold that the tests should be repeated. If they are to be repeated, the only fair thing for every man to do is to wipe out from his mind all previous impressions, and await the result of the second tests. But if they are not to be repeated, all he can do is to judge by the weight of evidence which exists, unless he chooses to evolve an independent opinion for his private use from his own inner consciousness. We decline to do this. For the present we have no opinions. If there is no movement soon toward a second series of tests we shall conclude that the semi-official announcements of the results of the first tests cannot have been so very unfair, after all.

The American Society of Civil Engineers has issued the following circular under date of May 20, 1892.

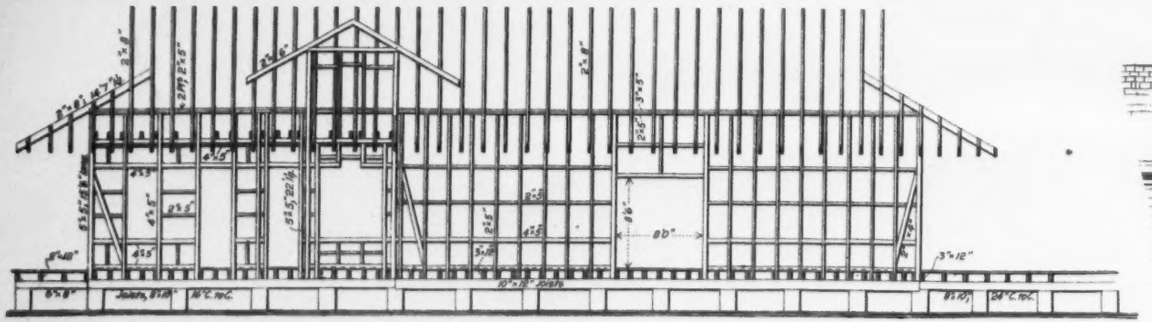
To the Engineering and Technical Press and to the Members of the American Society of Civil Engineers:

Owing to the fact that the printed notice at the top of the "Advance" copies of papers has been misunderstood or disregarded, to such an extent that the papers of the Society are often printed practically in full, before they appear in the "Transactions" of the Society, the Committee on Publications have adopted the following rule:

Abstracts of papers will be published, as far as practicable, in the "Bulletin," and generally in advance of the time they are to be read. Such abstracts may be republished immediately, but no other publication of the papers in advance of their appearance in the "Transactions" will be permitted without the written approval of the Secretary. This applies to discussions as well as to the papers themselves. The propriety of these requirements will be obvious to all. Advance copies are subject to correction, and often liable to considerable alteration. The Society must withhold publication for a reasonable time to secure thorough discussions; the publication of which, with a paper, greatly increases its value. Premature publication is unjust to the author and unfair to the Society. No paper will be published in the Transactions which has been previously published elsewhere; and the Society owes it to itself and its members to guarantee that originality of publication which it demands from them.

The publication committee will insist upon rigid adherence to this rule, the only alternative to which would be to recommend the abandonment of the issuance of "Advance Copies," the publication of which has heretofore been very satisfactory, excepting in this particular. F. COLLINGWOOD, Sec'y.

We trust the publication committee realizes what it has done in this circular, and will either live up to it or withdraw it. It has, in effect, declared that it "will insist on a rigid adherence to the rule" that no reports whatever shall be made of any of the technical proceedings or discussions at any of its meetings or conventions "without the written approval of the Secretary" or except as published in the newly established "Bulletin" or in the "Transactions." As the abstracts in the "Bulletin" (so far, at least) seem to be intended to advertise the paper rather than to give information of value, and as the papers when printed in the Transactions are usually from three months to two years old, this new rule means the complete exclusion from the engineering journals of technical matter laid before the society in papers or in discussions, except when of special importance. It means, for instance, that no journal can prepare a fuller report of the coming convention at Old Point Comfort than to say that such and such persons attended and such and such papers were read. We have no objection to this rule if it suits the society and the authors of papers, and if the committee will in fact take pains to insure that it is "rigidly adhered to" until it is withdrawn. But we do object to the implication that such a sweeping rule was necessary in order to prevent the printing of papers "practically in full." That implication is utterly unfounded. All that it has been or is necessary for the society to do is to say explicitly just what its wishes are as to abstracts—whether they may be half or a quarter or a third as long as the paper itself; whether they may or may not be accompanied by a part or all or none of the illustrations, and all reputable (or disreputable) journals will respect these conditions. They have such conditioned matter in their hands all the time.



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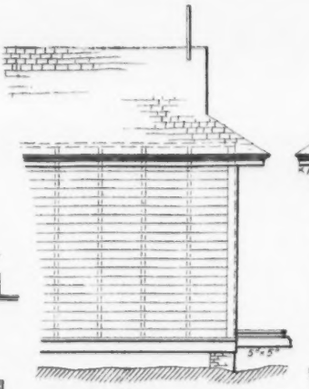

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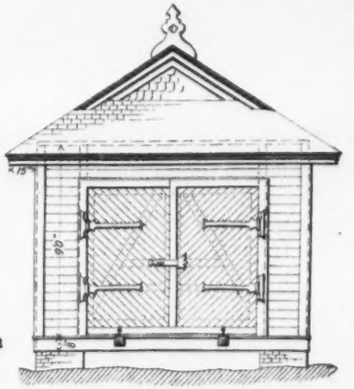

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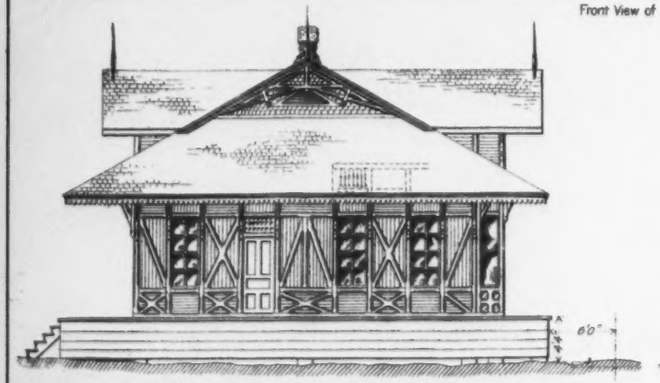

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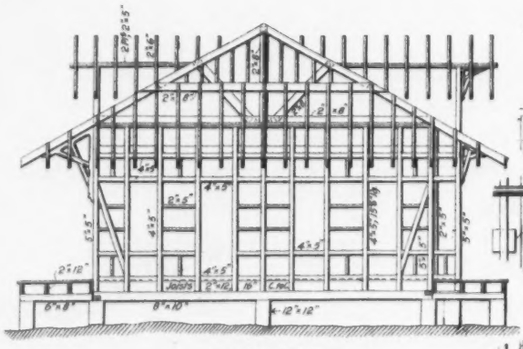

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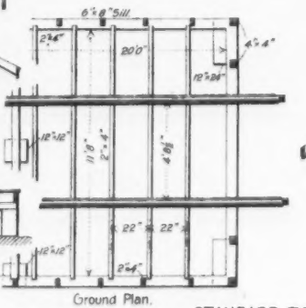
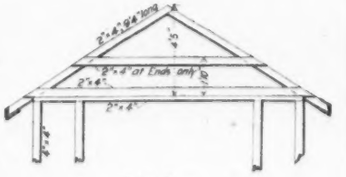
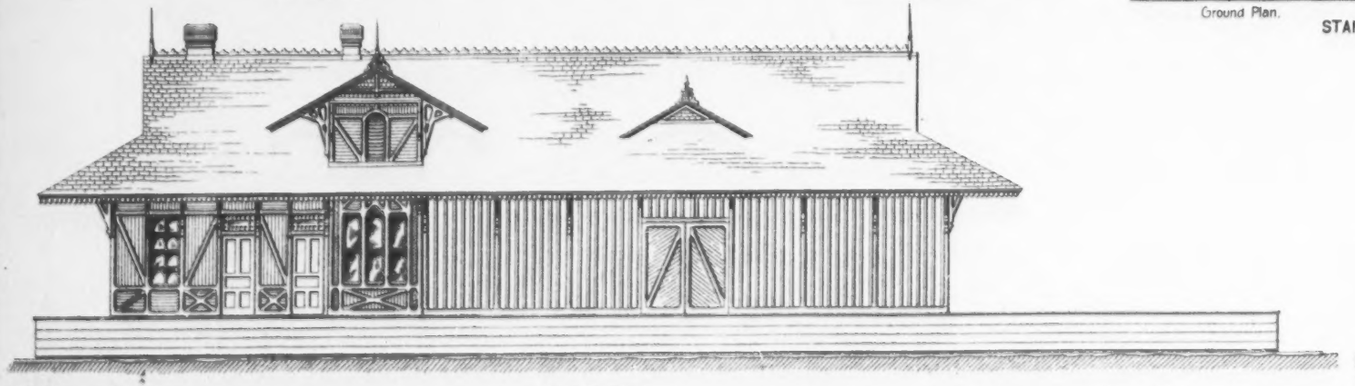


Ground Plan.



Roof Frame.

STANDARD TOOL HOUSE.



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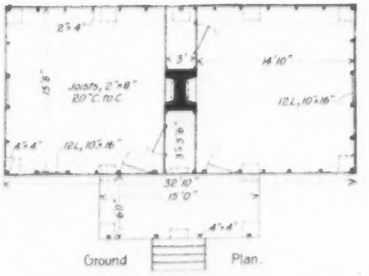
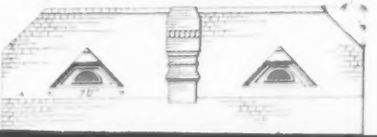
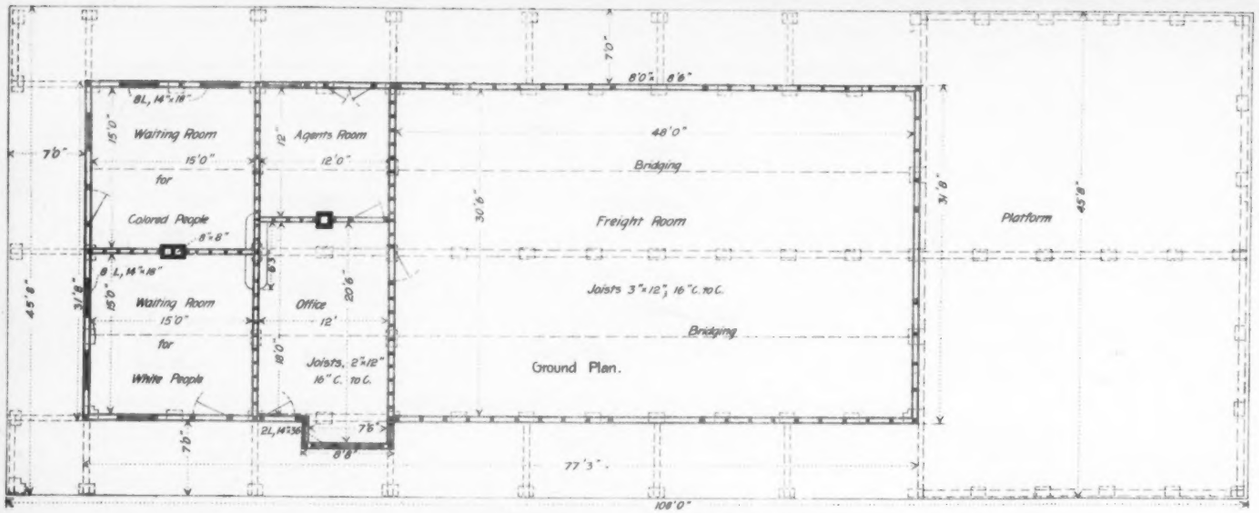


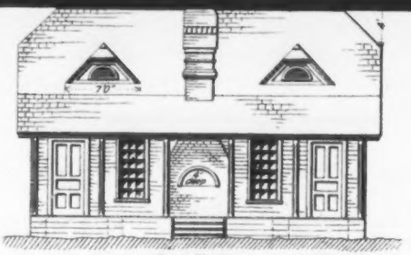
Ground Plan.

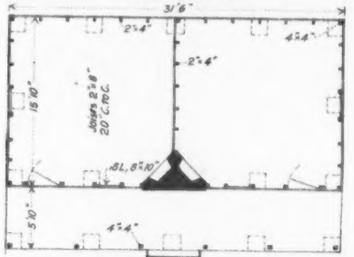
PLAN OF TWO-ROOM SECTION HOUSE, No. 1.



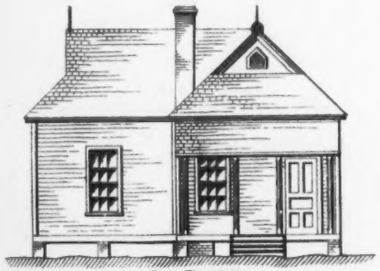


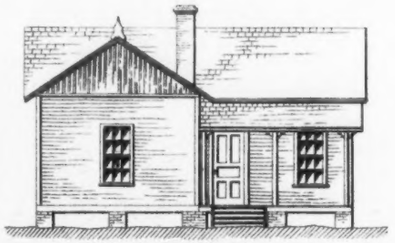
STANDARD PASSENGER AND FREIGHT STATION.

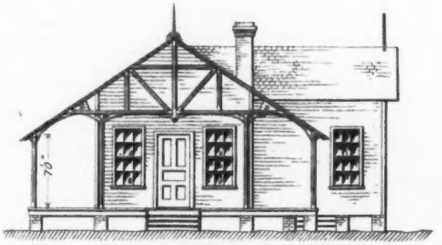


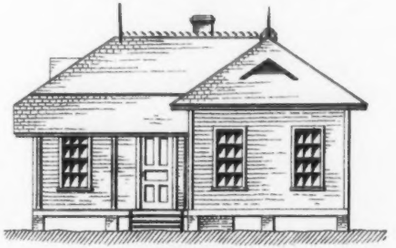


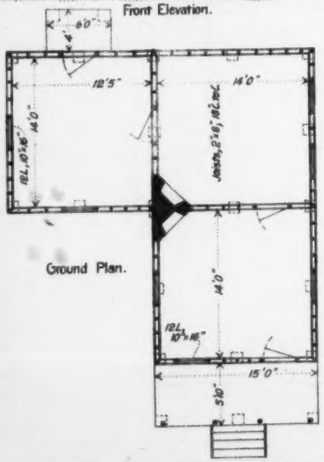
TWO-ROOM SECTION HOUSE, No. 2

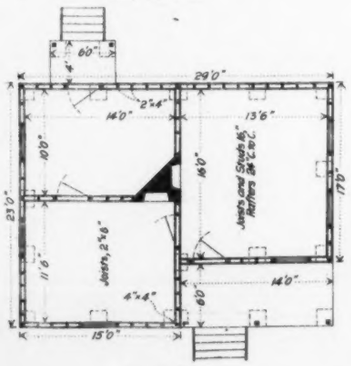


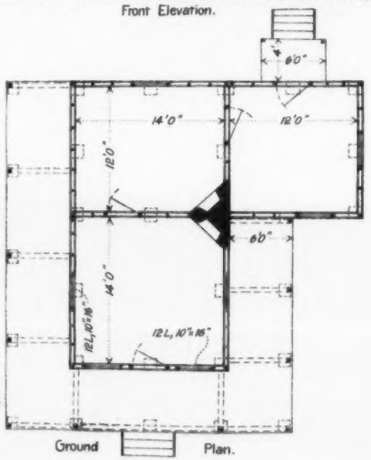


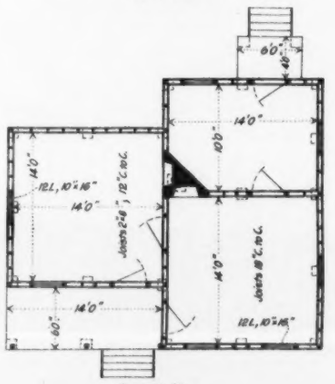


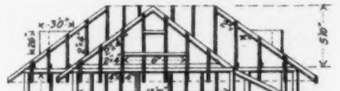


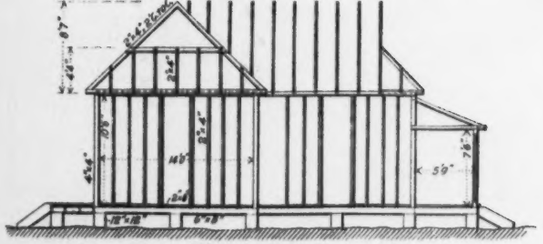












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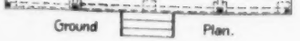
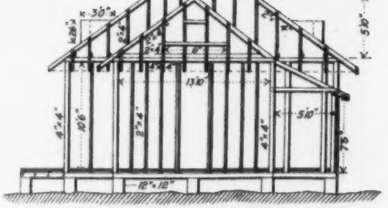


Ground Plan.

VARIOUS DESIGNS FOR THREE-ROOM SECTION HOUSES.



View of Frame from "A".

STANDARD STATION AND SECTION BUILDINGS, MACON & BIRMINGHAM R. R.

W. H. Wells, Chief Engineer. H. Tambs Lyche, Assistant Engineer.

CHAS. HART & SONS, LITH., 96 VESEY ST., N. Y.

The trouble is, and the only trouble, that the society has never done this, but simply forbidden advance "publication," while permitting abstracting. Very naturally, every journal gave as full abstracts as the importance of the paper seemed to warrant and its space permitted, short of complete reprinting.

WHIST HANDS AND THE "DOCTRINE OF CHANCES."

We fear that the London "Times" has been imposed upon, or else that Mr. "T. D. G.," of the New Club, Brighton, is a simple-minded kind of person who has been made the victim of a practical joke. He contributes to a recent issue of the "Times" the following account of what is justly described as an "extraordinary deal at whist."

To the Editor of the Times:

I fear it is not your custom to notice such subjects, but, as a combination occurred at this club (New Club, Brighton), which according to the doctrine of chances, would not occur again once in a billion times, perhaps you may make an exception.

After the cards had been thoroughly shuffled by the adversaries and the dealer, they were dealt, when the dealer was found to have thirteen trumps, and each of the other three players had a complete suit from ace to deuce. T. D. G.

Now, there is nothing impossible about this on its face, especially as the "doctrine of chances," which is so learnedly referred to, teaches us that this extraordinary hand,13 cards of one suit in each hand, is yet as likely to be dealt as any other one set of hands which could be named. It is also true that there is an almost infinite number of permutations of the pack which may be made and still deal out this wonderful set of hands. The precise number of such permutations is expressed by the tremendous logarithm 40.47729, which, converted into Arabic numerals, means that there are 36,081,000,000,000,000,000,000,000,000,000,000,000,000 ways (or thereabouts) in which the pack can be arranged, and yet result in giving to each player a hand containing one complete suit of 13 cards only.

Moreover, hands which are pretty nearly all of one suit are very common. Every old whist player has held eight or nine trumps repeatedly, and has dreamed of sitting some day at a table where the four or five loose cards should disappear and he should hold the whole 13, to brag of ever after.

And yet there could not be a better illustration than this alleged but impossible hand of the vast gap between a mathematical and a practical possibility. While 13 cards all of one suit may be dealt to each of four players to-morrow by any one as well as any other one set of hands, the probability of dealing it is so inconceivably remote as to make it morally certain that "T. D. G." was either deceived or himself a deceiver. It is so remote that if his life depended on convincing a jury of the possible truth of his statement, and the real facts were properly laid before them, no jury of sane men could well acquit him.

The odds against such a combination happening may be determined as follows: In order that the alleged set of hands should have been dealt, it is necessary that the pack before dealing should have chanced to arrange itself into 13 sets of four cards each, each set containing one card of each suit, and with the suits always in the same order. To determine the number of different ways in which this can happen, which is the vast number just given, it is easy to determine that, in the first place, the four suits in each group may have any one of $1\times2\times3\times4=24$ orders, and the required deal will still be made, provided only that each of the 13 groups have the suits in the same order. It hardly seems as if four cards could be arranged in so many different orders, but a brief trial will show that they may.

But, in the second place, with either of the 24 arrangements each of the 13 cards of the trump suit may be shifted about among themselves into $1\times2\times\ldots\times13$ different permutations, the logarithm of that product being 9.79427, and its value about 6,226,900,000. And after this has been done, with any one of these billions of permutations of the cards in the first suit, some other suit may have as many; and with each of all these, the third suit may have as many, and with each permutation of these three suits the fourth suit may have as many, so that we have as the final result, for the possible number of permutations of the pack of 52 cards, by which the alleged set of hands can be dealt, the following:

Log 1.2.3.4 (permutations of the four suits)....	1.38021
Log 1.2...13 (permutations within one suit) 9.79427x4 for permutations of the four suits.	39.17708
Log of total possible permutations.....	40.55729

Approximate numerical value of this log:
36,081,000,000,000,000,000,000,000,000,000,000,000,000

But the possible number of permutations of the entire pack is a much vaster number yet. It is expressed only by the continued product of the successive numbers 1.2.3...51.52. It might take a day (we do not care to put it to test) accurately to perform this multiplication, but substantial accuracy can be obtained more easily by adding together the logarithms of the natural numbers from 1 to 52.

This log of 1.2...51.52 is.....	67.90661
Deduct log of permutations to give the required complete suit to each hand.....	40.55729
Gives as the log of odds against four hands of one suit only being dealt.....	27.34932

Approximate numerical value of this log:
2,235,200,000,000,000,000,000,000,000

Once in this number of deals, and not "once in a billion," is what the "doctrine of chances" really gives as the probability of T. D. G.'s alleged set of hands being dealt.

The odds against any one hand having a complete suit of 13 cards is an almost infinitely smaller number than this. One or two such hands (but one or two only) are on record. There are several different ways of computing the odds against such a hand, which of course give identical results; but the method corresponding to that which we have used above (using the entire number of possible permutations of the pack of 52 cards as a basis) is as follows:

With the pack arranged to deal a complete suit to some one hand, each successive group of four cards in the pack must have its first, second, third or fourth card (=4 permutations) always of the same suit. With the pack thus arranged we may, in the first place, shift about the 13 cards of the given suit into 1...13 different orders without affecting the hand dealt, and with each one of these different arrangements of one suit we may, in the second place, shift around the remaining 39 cards into 1...39 different orders.

Log 4.....	0.60206
" 1...13 (possible arrangements for the given suit).....	9.79427
" 1...39 (possible arrangements for the other cards).....	46.30955
Log of number of permutations giving a complete suit to some one of the four players...	56.70588
Log of all possible permutations of the pack..	67.90661
Log of odds against dealing anyone a hand all of one suit.....	11.20073
Approximate value of this log.....158,775,000,000 a	

As we have already determined the odds against dealing all four hands all of one suit, by dividing the one by the other we shall have the odds against the other three hands being all of one suit, AFTER one player has found that his own hand contains one suit only, as follows:

Log of odds against all four hands being of one suit.....	27.34932
Log of odds against one hand being of one suit	11.20073
Log of odds against the three other suits being each in one hand only, after one suit has been found to be so.....	16.14859

The value in numbers of this logarithm is a little less than 14,080,000,000,000,000. In other words, it might happen that some one hand in a deal is all of one suit for uncounted and uncountable thousands of millions of times before it will happen once that the other three hands also are of one suit. b

b This same result may be reached in a more direct way thus: The pack being arranged to give some one hand 13 cards of one suit only, the possible number of permutations of the remaining 39 cards is (log).....	46.30955	
Of these, the number which will give the three remaining hands each a complete suit is $1\times2\times3$, log.....	0.77815	
log 1...13. 9.79427, x 3.....	29.38281	30.16096
Log of odds against the three other suits being each of one suit.....		16.14859

Being the same log as that differently determined above.

a The exact value of this number, as determined by direct multiplication is 158,753,389,900. From this number, 1 should be deducted, strictly speaking, to express the odds against the event, but that refinement we neglect in this article.

Now, let us suppose that in the whole world there are so many as 100,000,000 people who at some time or other in their lives play whist, and that so many as 1,000,000 of them sit down nightly to spend an evening at the game and play an average of 10 hands each. This is a tremendous stretch of probability. Out of all that vast multitude there are not more than 10,000 to 100,000 at most who really play the game, and so have any reason to enjoy it, but it is well known to many sufferers that, for every person who really plays the game, there are hundreds who enjoy going through the motions; so we will grant that 1,000,000 play nightly. A brief computation will show that this requires the dealing of $250,000\times10=2,500,000$ hands every night somewhere in the world, or 912,500,000 hands per year, if we count in Sundays and all. Let us call it in round numbers 1,000,000,000.

Under this very liberal assumption as to the amount of whist-playing in the world, the chances are that, at the present rate of playing, a single hand, all of one suit will turn up somewhere in the world once in about 40 years (one-fourth of 158.75 years, there being four hands in every deal); but a deal giving all four hands of one suit is likely to turn up once in 2,235,200,000,000,000,000 years. It is useless to attempt to express in words the inconceivable vastness of this number. The mind cannot comprehend it, but it is some aid to say that it would not be materially diminished if the entire population of the globe (old enough to sit up at a table) were to begin playing whist night and day and keep it up throughout their lives for centuries to come, intent upon getting even with "T. D. G." by getting a glimpse of that extraordinary hand. For that would only mean that, say 1,000,000,000 people would play some 100 hands daily, being about 36,500 times as much playing as we have assumed, and if we assume this to be continued for 300 years, the only effect is to strike off seven zeros from the end of the above number. The odds are still 223,520,000,000 to 1 against the hand being dealt by all those people in all that time, or greater than the odds against every hand dealt containing 13 cards of one suit only.

Of the single hand all of one suit, which we have computed may happen once in 40 years, there are but two instances of which we can discover any record. There may have been others, but the chance is always strong that any such alleged instance is bogus. The late Prof. Richard A. Proctor in his book "How to Play Whist" (Longman's, 1885) devotes some little space to notes upon whist oddities, and among them gives the following note:

All Trumps in One Hand.—Two cases were recorded a few years ago in "Westminster Papers," and the editor made the remark that this showed mathematicians to be wrong in stating that the odds were 159,000,000,000 to 1 against it..... It would not be much out of the way to say that among all the whist-playing nations of the earth, a million whist players play (daily meant, but not stated) per annum, and say that in each case there are 20 deals. Then it would require only 7,950 days, or not much more than 20 years, to give 159,000,000,000. The exact odds against the dealer having 13 trumps are 158,753,389,899 to 1.

It will be observed that Prof. Proctor estimates that just twice as much whist-playing is done in the world as we have guessed above. We did not discover his estimate until our own had been written, and have permitted our own to stand precisely as originally made. The two are in fairly close agreement, for so very vague a matter, but we still consider our own guess to be a "tremendous stretch of probability." The only difference between the two estimates, in fact, is that we allowed for only 10 hands nightly for each person instead of 20.

This alleged whist hand furnishes an excellent example of how the theory of probabilities can be used to test the credibility of witnesses, or of ex post facto explanations of events, with great advantage in many cases, when claims are made which, while not absolutely impossible, are yet highly improbable. Especially when the concurrent happening of two events at the same moment of time is alleged, as that a train chanced to derail itself just as an exceptionally severe gust of wind struck it (which was one of the theories advanced to explain the Tay Bridge disaster), the theory of probabilities can often be used to determine the reasonableness of such a theory or explanation with destructive effect. What is the chance of a train derailing itself at a given moment? What is the chance of an exceptionally severe gust of wind at a given moment?

The product of the two is the chance of both happening together at that moment.

LETTERS TO THE EDITOR.

THE POUGHKEEPSIE BRIDGE.— CORRECTION.

Sir: In the table of long span bridges given in your issue of May 12, page 471, the Poughkeepsie bridge is noted as for "Single Track Railway." We beg to call your attention to the fact that this is an error; as it carries a double-track railway. -Yours truly,

The Union Bridge Co.

New York, May 19, 1892.

(Our readers will please make the proper correction in their files, to avoid perpetuating and disseminating an unfortunate slip of the pen.—Ed.)

GARBAGE CREMATION.

Sir: There will be no great amount of sewer work done here this season, as we are behind with our plans. At present we are going to let about half a mile of storm sewer on June 6. I would be indebted to you for some information on burners for night soil and garbage. Yours truly, John Krey, Cy. Engr.

West Duluth, Minn., May 18, 1892.

(Some particulars of English experience with garbage cremators were given in our issues of Sept. 12 and Dec. 26, 1891. The Engle Sanitary & Cremation Co., of Des Moines, Ia., has put in several plants in this country for the cremation of garbage and night soil.—Ed.)

SHIP RAILWAYS IN EUROPE.

Sir: The general idea of ship railways was first brought forward in France by Mr. A. Sebillot in 1870; on returning from a visit to the Isthmus of Panama. The system was afterward advocated before Count de Lesseps, but he would have nothing to do with it.

The failure of the canal works at Panama has again brought forward the subject of ship railways, and the French Government has quietly sent an inspector to Panama, and after his return, will consider whether there is still a possibility of transporting ships across the isthmus. Among the different schemes submitted, the ship railway of Mr. Sebillot has been retained for further examination. A small ship railway for the use of country canals has been approved by the Conseil General des Ponts et Chaussees.

The estimated cost of completing the sea level canal up to kilometer 41 on the Colon side and to kilometer 61 on the Panama side, with a ship railway 20 kilometers long, connecting the two, is not over $50,000,000 or 250,000,000f. This sum would leave a large remuneration for the old capital, and the amount due on the last issue of shares, which have not been recovered, owing to the liquidation, would be sufficient to pay for the completion of the works without a further issue of shares. There is no doubt on this side that if the canal is completed it will be by a ship railway.

Panama is not the only isthmus in which France is greatly interested. Adjoining the country itself there are two seas whose junction would be of great benefit. In Europe, the competition for the dominion of the Mediterranean is very great. At present, England appears to have the lead, as she owns Gibraltar, Malta, Cyprus, and also Egypt, notwithstanding the new Khedive, who appears to be willing to escape from the English rule.

If France could send its warships from the Atlantic to the Mediterannean without passing by Gibraltar, there is no doubt that it would be a great offset to England's naval power. Besides its military advantage, there is now a traffic of over 20,000,000 registered tons passing by Gibraltar straits yearly, and it is increasing at about 6% per year. The saving of time by a ship railway would be nearly five days for all ships passing from Ushart (near Brest) to the east of a straight line between Barcelona and Tunis.

The toll charged could be 6 francs ($1.20) per registered ton, and this would leave the ship owner 4 francs ($.80) per ton. The petition for a concession has been deposited, and with the favorable report on the ship railway for country canal use, it will, no doubt, be granted.

Among other schemes in this line is the plan to make Paris a seaport, and there is some talk of connecting the Black Sea with the Caspian, which, if done, would greatly increase the competition in the petroleum market. Happily for your countrymen interested in this line, the cost will be too great to make this scheme a practicable one. American petroleum will continue to be imported in Europe for long years before the Caspian and Black sea traffic will suffice to induce ship railway construction.

The Atlantic and Mediterranean ship railway, however, is by far the most important of all the schemes submitted. It would oblige England to have on each side a naval force twice as strong as the French squadron, for it would be possible for the latter to cross in 20 hours. The estimated cost is $120,000,000, and the revenue which would be recovered, if all the traffic used the canal that might use it with a notable gain, would be $55,000,000. Of course, all this tonnage would not use the railway, but even a small part of it would pay a large interest on the money invested.

Yours very truly, A. H. Duthil.

Paris, Feb. 15, 1892.

PELTON WHEELS UNDER 2,100 FT. HEAD.

A notable water power installation, working under what we judge to be by far the greatest head ever known, has recently been made by the Pelton Water Wheel Co. in one of the Comstock mines at Virginia City, Nev. The wheel is 36 ins. diameter, made of a solid steel disk with the buckets riveted on to the periphery, and weighs complete 180 lbs. It is running under a vertical head of 2,100 ft., equal to 911 lbs. pressure; 460 ft. of this head is obtained from the pipe line of the Gold Hill Water Co., and the remaining 1,640 ft. from the shaft down which the pipe line is run to the Sutro tunnel level, where the power station is located and through which the water discharges after passing over the wheel. The wheel runs at 1,150 revs., with a periphery speed of 10,804 ft. per min., or about 120 miles per hour. Running without load, the wheel would attain the enormous speed of 21,608 ft. per min., equal to about 240 miles per hour, and provision for the great strains due to this speed have been made. A nozzle tip of ½-in. diameter gives under the above conditions 100 HP. Every miner's inch of water, equal to a flow of 1.6 cu. ft. per minute, is said to give 5 HP., while 1 HP. is given for every 2 lbs. of metal in the wheel. The column of water is more than four times as high as the Washington monument and more than twice the height of the Eiffel tower, and exerts a pressure at the bottom of about 910 lbs. per sq. in. The theoretical HP. of each 1.6 cu. ft. (100 lbs.) of water is 6.37 (210,000 ft. lbs.), so that the efficiency of the wheel under this enormous head, if the above data are correct, is 78½%.

The installation made by the same company some two years ago in the Chollar shaft on the Comstock lode is in some respects no less extraordinary. This consisted of six 40-in. Pelton wheels, running under a vertical head of 1,680 ft., and driving six electrical generators, the power from which is conveyed up the shaft to the Nevada mill, some 2,000 ft. distant. These wheels only weigh 220 lbs. each, and with nozzle tips ⅝-in. diameter develop 125 HP. each. The water is first run over a Pelton wheel on the surface under 460 ft. head, and is then carried down the shaft by a pipe to the Sutro tunnel level, where the underground station is located, the power from the electrical generators being conveyed to the counter shaft of the mill with which the surface wheel is connected. An interesting illustration of the double use of water is here given, some 400 HP. being produced in this way from what may be termed waste water. This station has been running more than two years without interruption and practically without expense in the way of repairs, showing the advantages of water power and electric transmission, as well as the reliability of such a plant.

HOW TO PLACE STEAM VALVES.

Should a globe valve on a steam pipe have the steam pressure on top or underneath the valve, is a question which has been under discussion in the columns of the "American Machinist." On the one hand, it is said that with the steam pressure on top, the stuffing box around the valve stem cannot be repacked without shutting off steam from the whole line of pipe; on the other hand, if the steam pressure is on the bottom of the valve, it all has to be sustained by the screw thread on the valve stem, and there is danger of stripping the thread.

A correspondent of wide experience states, however, that it is a very uncommon thing in the ordinary globe valve to have the thread give out, but by water hammer and merciless screwing the seat will be crushed down quite frequently. Therefore, with plants where only one boiler is used he advises placing the valve with the boiler pressure underneath it. On plants where several boilers are connected to one main steam pipe he would reverse the position of the valve, then when one of the valves needs repacking the valve can be closed and the pressure in the boiler whose pipe it controls can be reduced to atmospheric by lifting the safety valve. The repacking can then be done without interfering with the operation of the other boilers of the plant.

He proposes also the following other rules for locating valves: Place valves with the stems horizontal to avoid the formation of a water pocket. Never put the junction valve close to the boiler if the main pipe is above the boiler, but put it on the highest point of the junction pipe. If the other plan is followed, the pipe fills with water whenever this boiler is stopped and the others are running, and breakage of the pipe may cause serious results. Never let a junction pipe run into the bottom of the main pipe, but into the side or top. Always use an angle valve where convenient, as there is more room in them. Never use a gate valve under high pressure unless a by-pass is used with it. Never open a blow-off valve on a boiler a little and then shut it: it is sure to catch the sediment and ruin the valve: throw it well open before closing. Never use a globe valve on an indicator pipe. For water, always use gate or angle valves or stop cocks to obtain a clear passage. Buy if possible valves with renewable disks; the saving is enormous. Lastly, never let a man go inside a boiler to work, especially if he is to hammer on it, unless you break the joint between the boiler and the valve and put a plate of steel between the flanges.

NEW HARBOR AT MALMO, SWEDEN.

The Harbor Board of Malmo, Sweden, has decided to receive competitive plans for the construction of a new harbor, and has offered prizes of $2,220, $1,385 and $830 for the three best designs. The drawings and documents must be submitted by Sept. 1, 1892. The accompanying map shows the extent of the scheme proposed, and a large scale map may be obtained from the Harbor Board on payment of $2. The plans are to comprise the parts north and east of the dotted line. The mole or pier (A B) concerns the plans only so far as it may be thought necessary to provide communication for shipping traffic between the old and the new harbors. The entrance channel concerns the plans in question so far as any widening thereof may possibly be considered necessary in order to provide a separate entrance into the new harbor or as any alteration may be demanded by the construction of the new harbor.

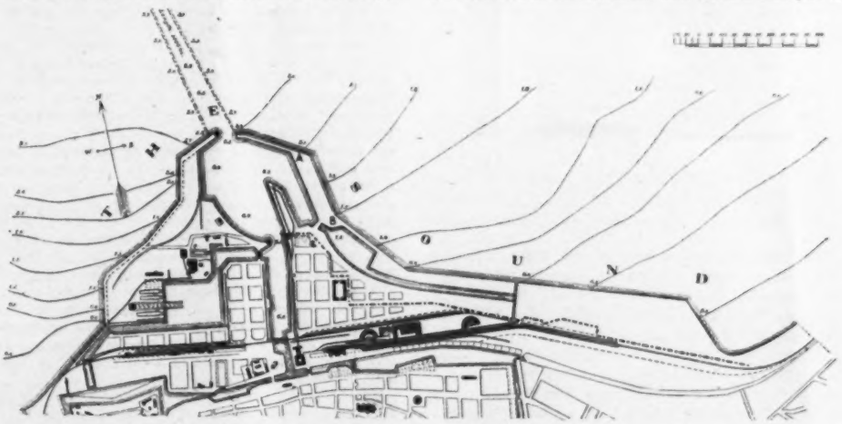
On the map the position of the ground which enters into the plans, and which has partly been filled up, is given as it appears when the water is at its normal level. The natural depth of the water is indicated by the figures at each end of the contours. It has been ascertained by borings already made, and must be assumed as a basis for the estimate of cost, that to a depth of 26.24 ft. the bottom consists of about 2 ins. of sand and 24.6 ft. of hard clay.

The harbor must include commodious berths for vessels of the largest size which, the depth of water in the Sound being taken into account, may possibly put into Malmo, a draft of 24 ft. The design is to be made under the assumption that the work of constructing the harbor will be spread over a period of 15 years. It should be accompanied by the designer's opinion as to the method which should be adopted in the construction of the harbor basin, and also as to the order in which the work should proceed, so that the parts of the harbor as they are completed may at once be put into use. It is assumed that the quays will be built on piling. The competitors are, however, at liberty to add a special proposal with regard to the employment of other materials for the whole harbor or any part of it. An exact description must be given of the bridges that it may be proposed to build. Within the harbor, or in the neighborhood thereof, must be a berth for two steam ferryboats, with room on each for lines of rails for eight railway freight cars. The design should give information as to the system of cranes best suited for the harbor, and also as to other necessary or useful machines for loading and discharging. A photograph should be inclosed of the cranes recommended, showing their construction. Lines of rails must be laid from the State Railway station to such an extent and in such a manner as to effect the best arrangements for the cheapest possible transport of freight to and from the railway.

On the plan must be indicated places for the fol-

lowing buildings: Warehouses with accommodation for the storing for lengthy periods of different sorts of freight; special warehouses with hoists for grain, in connection with one or more drying kilns; quarantine accommodation for imported cattle and a place for the inspection of cattle destined for exportation; storehouses or sheds for the temporary storage of freight imported or destined for exportation; custom house and bonded warehouses; power house for electric lighting; offices for the harbor engineer and the harbor master, dwelling houses for the latter and the other necessary harbor police, and a yard for the harbor stores. The plans must also provide space for the requirements of the coal trade and for the drawing up of a number of railway cars sufficient for this purpose; place for "kips" or similar machines to be employed in the coaling of vessels; place for manufactories, etc., of such a description as to require access to the quays for loading and discharging; and accommodation for the storage of timber.

The sea front is to be so arranged as to afford an easily accessible promenade, sheltered from the waves. Street paving, sewers, water and gas pipes and electric wires are to be provided for. It is assumed that in the harbor there will be no other passenger traffic than that resulting from the railway steam ferry. Plans are to be given of the bridges, ferry landings, warehouses and buildings, location of tracks, etc., and are to be accompanied by a description of the proposed works and an estimate of cost. The successful designs will become the property of the Harbor Board. The jury of award will consist of Col. J. G. Richert, Chief of the Royal Swedish Board of Roads and Waterways; Mr. F. Andreas Meyer, Chief Engineer of Public Works at Hamburg; Mr. G. Royers, Chief Engineer of Public Works at Antwerp; and with these will be associated as alternates Capt. P. Laurell, Royal Swedish Engineer Corps; Mr. G. Franzius, Chief Engineer of the imperial dockyard at Kiel, and Mr. F. DeWinter, Chief Engineer of the Marine Department at Antwerp.



NEW HARBOR FOR MALMO, SWEDEN.

WORLD'S COLUMBIAN EXPOSITION.

Comparative Statistics.

A report has been submitted to Congress by the World's Fair Investigating Sub-Committee of the House Committee on Appropriations, expressing entire confidence in the success of the exposition, and stating that it will far exceed all previous expositions. The invitation to participate has been accepted by 56 nations and colonies, which have made appropriations aggregating $3,783,900, and it is expected that 20 other countries will be represented. Complete exhibits will be made by all the countries which promise attendance, and 26 of them will erect special buildings for their own displays. Of the United States, 30 states and territories will erect buildings and make special exhibits, for which $3,182,500 have already been provided. It becomes obvious, therefore, says the report, that the expenditures of individual enterprise, of the states and territories, and of our own and of foreign governments, will reach the stupendous aggregate of not less than $30,000,000 for exposition purposes. The committee makes an estimate of income and expenditures to the time of opening, May 1, 1893, as follows: expenditures, $15,546,000; income, $10,763,180; deficiency, $4,782,820. The total estimate for the exposition is as follows: income, $29,275,482; gate receipts, $12,250,000; concessions, $4,800,000; subscriptions, $5,944,500; Chicago city bonds, $5,000,000; expenditures, $19,319,088. An appropriation of $3,000,000 has been made by Congress. In our issue of Jan. 30 we gave statistics of several of the previous international expositions, and we give below a tabular summary of some of the most important figures for the Centennial exposition at Philadelphia, 1876; the Paris exposition, 1889; and the coming World's Columbian Exposition at Chicago, 1893. For the latter the amounts are of course estimated, and the foreign appropriation, being already nearly $4,000,000, will certainly be much increased.

	Philadelphia.	Paris.	Chicago.
Expenditures	$11,161,611a	$8,000,000	$19,319,088
Income	11,133,675	10,000,000	29,275,482
Gate receipts	3,834,250	7,400,000	12,250,000
Concessions	500,000	500,000	4,800,000
City appropriations.	1,500,000	1,000,000	5,000 000
National "	1,500,000	3,400,000	3,000,000
Foreign countries and colonies	55	50	76
Approp. from same.	1,100,000	4,077,000	3,783,000b.

a. Of which $2,500,000 was paid by the state of Pennsylvania and city of Philadelphia, leaving $8,661,611 as the amount paid by the exposition management.
b. For 56 countries.

Terraces and Interior Docking.

The following particulars of the carpentry and exterior covering for terraces and interior docking are taken from the specifications for that work. The exposition management will furnish and put in place all the piling for the retaining walls of the upper terraces, for the water fronts or docks and for the boat landings and steps. This will include the piles and timber caps, the sheet piling necessary to retain the earth in place, and the wales and face plank of the water fronts or docks. The general form of construction of the water front walls was shown in our issue of April 21. All the framing timber, wales, joists, stringers, step planking, columns, etc., must be of sound common white or Norway pine, thoroughly seasoned and free from knots, shakes, rot, sap angles and other defects, and must be carefully dressed on all exposed edges. The joints of all framing must be cut and fitted close and accurately. Nails and spikes must be clean cut steel or wire nails or spikes of the standard sizes. In general, the milling will be as follows: 2-in. plank blind nailed, 20d., 4 ins.; 2-in. plank full nailed, 30d., 4½ ins.; 2-in. bridging or bracing and 1-in. rough bracing or sheathing, 10d., 3 ins.; ⅞-in. lumber, 8d., 2½ in. brads. The top rail and base of balustrades must be bored to receive the core of the cement balusters. There will be steps from the upper to the lower terraces at certain places. At each landing a float is to be built of strong wooden frames and 2-in. plank, calked with oakum and made water tight. All steps and exposed sheathing will be of 2-in dressed white pine planed, and the treads will be matched.

The contractor for cement work will form a ground work for all the solid cement steps, pedestals, etc., of concrete composed of clean, screened 1½ in. broken stone, and first quality fresh English or German Portland cement in the proportions of one measure of cement to four measures of stone. All the surfaces to be well tamped and leveled, filling up all interstices, and all surfaces then covered with 1½ ins. of first quality fresh English or German Portland cement and clean sharp sand in the proportions of one part of cement to two parts of sand. All surfaces are to be formed to the outline shown on the drawings, and troweled or molded hard and smooth. The lower part of all retaining walls, not less than 8 ins. in width, will be covered with the cement as specified for the finish of steps. All other work, including the turned balusters, covering of caps, posts, retaining walls, etc., of railing and balustrades, the covering of pedestals, etc., is to be of plaster composition of sufficient strength and stiffness to span the distances required by the framing of the wood work, and of sufficient durability to resist the effects of the atmosphere and the strains to which it will be subjected in use. All models for ornamental moldings and relief work will be furnished by the management. All moldings must be made with an even surface and true profile, the connections between the different sections must be made evenly and fitted closely together, and after the work is in place all joints, crevices, etc., must be filled solid with the same material, so that the whole work when completed will be a perfect representation of cut stone surfaces. After the surfaces have been covered with a plaster composition and all the joints pointed and filled up, the whole surface must be painted with some liquid paint guaranteed not to crack, blister, flake or absorb moisture, the color to be selected by the Chief of Construction.

Exhibition of Models of Patents.

The following general letter to inventors and manufacturers of the United States has been issued by Mr. W. E. Simonds, Commissioner of Patents:

It is the intention of the Patent Office to make at the World's Columbian Exposition at Chicago in 1893 an exhibit which will show that great advance in the several arts which is due, in large measure, to the encouragement and support afforded by our patent system. This exhibit is to consist of models of patented inventions, which will be carefully selected, to show as far as is possible the inception of each art, the stages through which the art has advanced, and the final development reached at the present time. This display of typical inventions, embodied in concrete form and properly arranged, will, it is believed, constitute a grand historical exhibit of the progress of the useful arts and one which will be of great interest, not only to inventors and manufacturers, but the public generally.

The office collection of models has been seriously impaired by fire, and is further incomplete by reason of the fact that models have not generally been required or received during the last ten years. The office is not, therefore, in possession of the models of many valuable inventions which might properly be included in such an exhibit, and without which, indeed, the exhibit would be incomplete. The limited appropriation for this exhibit will not permit the office to make such models. An urgent appeal is therefore made to all inventors and manufacturers to come to the assistance of the office in this matter, either by loans of models already built or by the construction of such models not in the possession of the office as should properly be placed in such a collection. Of course, where models are loaned to the office all proper credit will be given both in labels and catalogues to the parties by whom the loans are made, and such disposition will be made of the models after the close of the exhibit as the owners shall direct. Many inventors and manufacturers have already indicated a willingness to co-operate with the office in this matter, and it is confidently expected that such a response will be made to this general appeal as will assure the unparalleled success of this attempt to graphically and concretely show the development of American invention.

The Patent Office unfortunately does not possess a complete set of models, as few models have been required or filed since 1880, and the fire of 1877 destroyed many of the older ones and seriously injured some of the most important parts of the collection. It is expected that 3,000 or 4,000 models will be exhibited in the 6,000 sq. ft. of floor space allotted to this purpose. The collection and arrangement of this exhibit is in charge of Mr. James Q. Rice, U. S. Patent Office, Washington, D. C.

Intramural Transportation.

The contract for building and operating the intramural railway has been awarded to the Western Dummy & Railway Co., the contract requiring the company to pay the exposition management a certain percentage of the gross earnings of the road. It is said that this amount will be 20 or 25 per cent. The route will be practically as shown on the map in our issue of Jan. 16, but with some alterations. The line will be a double track elevated structure, about 5½ miles long, operated by electricity, with

frequent trains stopping at stations at intervals of about 1,000 feet. The Thomson-Houston Electric Co. is at the back of the enterprise. The cost of construction and equipment is estimated at $450,000 to $600,000. The fare will probably be 5 cents. The Western Dummy & Railway Co. has a capital stock of $500,000. Its proposition was to run trains of four cars, including the motor, with a capacity of 320 passengers, but a greater capacity has been required by the management. There were a number of proposals for the contract. Holmes & Adams proposed to build a narrow gage electric road with the Decauville system of track and to pay the management a percentage of its gross receipts varying from 10% on $500,000 to 33 1-3% on $1,000,000; fare to be 5 cents. The Chicago Elevated Electric Ry. Co. offered to pay 1 ct. per fare or 50% of its gross receipts.

For transportation on the lagoon and canals several proposals were made for naphtha, steam and electric launches. No contract was awarded, but a proposition was made by the management and accepted by the bidders, providing that each bidder shall submit a specimen launch equipped with machinery, for actual test. The bidders are now building the full sized launches upon which their bids were based. The sliding railway will carry passengers along the entire length of the Midway Plaisance, having one track for through trains and one for trains stopping at three intermediate stations. The Standard Fireless Engine Co., of Chicago, has a contract to build and operate a short trial or exhibition line at the south end of the park, but this is not calculated to furnish transportation for the convenience of visitors, although passengers will be carried. The company's system consists of the McMahon ammonia motor, in which the pistons of the engine are driven by ammonia gas, the exhaust of which is turned into a tank and absorbed by the water. Other particulars of intramural railways were given in our issue of Jan. 16. It is also proposed to award a contract for the operation of carriages and vehicles in the park, and a cheap and efficient service of carriages will be a very desirable addition to the transportation facilities, as the vast extent of the grounds will make it very tiresome walking from place to place, and the elevated railway will not meet all requirements. Other methods of transportation, by electric, steam, and other cars, might well be provided, and need not be run at such speed as to be at all dangerous. In our issue of Jan. 30 we referred to the insufficiency of the transit facilities at the Paris exposition, owing partly to the unexpected traffic, and it is to be hoped that the authorities having this matter in charge will make ample provision for the intramural transportation, as any discomfort and inconvenience from insufficient accommodation will greatly detract from the success of the exposition. There is certainly a great deal of space to be covered, affording ample room for lines for exhibition and passenger accommodation.

Electric Lighting.

The contract for furnishing the incandescent electric lighting plant has been awarded to the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa., at $390,000 for 92,622 lamps, or about $4.30 per lamp, using the alternating current system. The original bid of a combination of the Edison, Thomson-Houston and other electric companies was $18.50 per lamp, or $1,713,507, which was rejected as being entirely too high, owing to the absence of competition. An outside company bid $5.45 per lamp, showing that the other bid was too high, and this led to new bids being advertised for, which resulted in the award as noted above. A similar combination bid of $38.50 per lamp was made for the arc lighting plant, but here again it was defeated owing to an outside bid, and it was proposed to invite bids from foreign companies. Eventually contracts at $20 per lamp were let to the Thomson-Houston and allied companies and the Western Electric Co. for 3,500 lamps, and to the Standard Electric Light Co., of Chicago, for 1,000 lamps. Foreign companies have been invited to furnish the balance of the lamps at the same price, and Mr. Sargent, the Electrical Engineer, made a trip to Europe to confer with the leading companies. The specifications for arc and incandescent lighting were given in our issue of March 12.

FUEL GAS PRODUCTION.

Mr. Arthur Kitson, inventor of a new and compact plant for producing what he calls "semi-water gas," recently read a paper before the Franklin Institute,* reviewing the whole question of fuel gas production. He compares the three forms of fuel gas known as "producer gas," "semi-water gas," and " water gas," the comparative chemical composition of which is graphically shown in the three accompanying diagrams.

Ordinary illuminating gas, while differing widely in composition, lies ordinarily between the limits below, with which we contrast the chemical composition of the fuel gases, as shown in the diagram.

	City ill. gas.	Producer.	Semi-water.
Hydrogen. H.....	28. to 46.0	2.8	14.
Carb. oxide, CO..	7. to 7.5	33.3	27.2
Nitrogen. N.....	0.4 to 0.5	63.4	53.3
Carb. acid, CO_2..	0.1 to 0.6	0.5	5.5
Lt. carb. hyd....	50. to 40.	.....	.....
Condensible hydrocarbons.....	13. to 4.	.....	.....
Other ingredients	1.5 to 1.4	.....	.....
Total.....	100.0 to 100.0	100.0	100.0

Pure water gas, as shown in the diagrams below, is composed of nearly equal parts of hydrogen and carbonic oxide, with an inconsiderable admixture of nitrogen and carbonic acid.

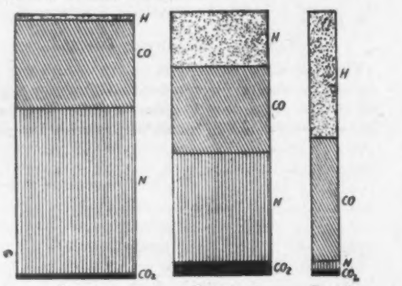


Fig. 1. Fig. 2. Fig. 3.

Diagrams Showing Comparative Volumes of the Various Constituents of Producer Gas (Fig. 1), Semi-Water Gas (Fig. 2) and Water Gas (Fig. 3) from Anthracite.

Producer gas and a form of semi-water gas were the earliest forms of fuel gas, and were invented and first produced in France in 1841. Producer gas was produced by the partial combustion of carbon by forcing a limited quantity of air through a furnace coutaining solid fuel in a state of combustion; the semi-water gas, by forcing a mixture of air and steam through in the same way. In pure water gas, only enough air is supplied to maintain the temperature of combustion.

Twenty years later the Siemens regenerative furnace was introduced, and the startling results achieved by its inventor in metallurgical work rapidly opened a wide field for the use of fuel gas in the iron and steel industries. It was demonstrated that 7 cwt. of coal would do the same work that had hitherto been performed with a consumption of at least 40 cwt. of coke in heating one ton of iron to welding heat; and 12 cwt. of coal replaced 60 cwt. in melting one ton of steel by means of this gas furnace. The success of fuel gas for metallurgical work was at once assured.

Until the supply of natural gas in Pittsburg had created a demand among domestic consumers for this desirable addition to modern household conveniences, there had been scarcely any attempt to provide private dwellings with any other than illuminating gas. It is true that some attempt was made in Germany to introduce a heating gas, and that as long ago as 1862 a company was formed in Birmingham, England, to supply that city with fuel gas at a cost of 12 cts. per M. cu. ft. This bill was actually presented to Parliament, but thrown out in Committee of the House of Lords, because their lordships thought that if the scheme was as good as represented by its promoters, existing gas companies would gladly engage therein. It is needless to say that the existing gas companies, already possessing the lighting monopoly of cities, did not care to undertake any experiments nor embark in fresh schemes, and it was reserved for an individual 25 years later to put the first fuel gas plant in operation for domestic purposes. In this country progress has been more rapid, owing, undoubtedly, to the presence of natural gas.

The ordinary city gas is an excellent fuel gas, except for its cost, but that objection, of course, is fatal to its use for heating purposes on any large scale, even were its price considerably reduced from present rates.

The heat in a ton of ordinarily good coal is perhaps 29,000,000 h. u., of which, however, hardly more than one-sixth, or say 5,000,000 h. u., is utilized for ordinary domestic uses. Of a gas, from one-third to one-half of the total heat is readily utilizable, so that, if we get in a gas from one-half to one-third of the total heat of the coal from which it is made, we are getting as much useful heat from it as from the coal.

Producer gas contains only about 35 per cent. of combustible gases, the great bulk of it being nitrogen. If the air consisted of oxygen only, the gas would be practically all carbonic oxide, and from 2,240 lbs. of anthracite, 4,666 lbs., or nearly 60,000 cu. ft. of gas would be produced, containing 20,200,000 h. u. of the 29,000,000 h. u. in the coal, or over two-thirds. As pure oxygen cannot be had, producer gas can only be used to advantage when burned on the spot, as in the Siemens furnace, so as to utilize the heat produced in making it. The advantages of the water gas process are thus described:

By injecting a mixture of steam and air, we require less air than where it is used alone, since the steam provides a certain quantity of the oxygen necessary to convert the carbon into carbon monoxide. The air maintains the furnace temperature essential for decomposing the steam in the presence of the red-hot coal; the oxygen of the steam unites with the coal to form carbon monoxide (CO), and the hydrogen remains free. The use of steam thus affords an enormous advantage. Instead of free nitrogen, we get free hydrogen, which is not only a highly heating and combustible gas, but exceedingly light, and confers low specific gravity to the gaseous products with which it is associated—a feature of considerable advantage where the gases have to be carried some distance before burning. Of course, the use of steam entails a consumption of the heat energy of the furnace, and it becomes a rather nice point so to proportion the steam and air that the fuel can maintain sufficient heat to carry on the chemical transformation of the steam to combustible gases, and reduce, at the same time, the quantity of air to a minimum. The less the amount of air used, the less the proportion of inert nitrogen in our fuel gas—a point to be aimed at; and the greater the proportion of steam, the greater will be the heating power of our gas, providing always the requisite furnace heat be maintained to decompose the steam effectively.

If we ascertain the heat generated in the furnace and that expended in effecting the chemical transformation of a given weight of steam into combustible gases, the furnace temperature can be known, and this will guide us in determining what amount of steam may be used with success.

Having given the following data, let us calculate the heat production with 800 lbs. steam, supplied from a boiler at 300 degrees F.; 2,240 lbs. anthracite or coke, containing 240 lbs. ash; 10,013 lbs. of air. We will allow for a loss of 20 per cent. of steam that will, in all probability, escape decomposition in the furnace; also 10 per cent. of carbon burned to CO_2.

	B.T.U.
1,800 lbs. of carbon burned to CO = 1,500 × 4,400 =	7,920,000
200 lbs. of carbon burned to CO_2 = 200 × 14,500 =	2,900,000
Heat carried in by steam, 800 × 300° × .475..... =	114,00 0
	10,934,000

The heat expended, allowing 20 per cent. of steam as wasted, in escaping through furnace without undergoing decomposition, is:

	B.T.U.
160 lbs. heated from 300° F. to (say) 1,300° F. 160 × 1,000 × .475..... =	76,000
Conversion of 640 lbs. of steam at 300° F. 640 × 53 900..... =	3 832,290
Allow 10% loss in furnace by radiation, etc..... =	1,093,100
	5,001,690

Then, 10,934,000 — 5,001,690 = 5,932,310 h. u. contained in the furnace.

Our furnace heat is determined as follows:

CO_2.....	= 732 lbs.	× 0.2164 =	158.4
CO.....	= 4,194 lbs.	× 0.248 =	1,040.2
N.....	= 7,000 lbs.	× 0.244 =	1,869.0
H.....	= 71.11 lbs.	× 3.4046 =	241.8
	12,657.11		3,309.4

The average specific heat is $\frac{3,309.4}{12,657.11}$ = .261 and the average furnace heat $\frac{5,932,310}{12,657.11 \times .261}$ = 1,800° F.

The proportion of gases by volume will be as follows:

H.....	12,700	Combustible, bout 30%.
CO.....	53,700	
CO_2.....	6,000	Non-combustible, 61%.
N.....	97,900	
	170,300 cu. ft.	

Now, this temperature is much higher than is neces-

*Jour. Frank. Inst., Dec., 1891, p. 424.

sary for decomposing steam, and shows that our proportion of steam to air is too small for economical work. We may, therefore, increase the weight of steam with advantage. Let us increase the weight of steam one-third, making it 1,200 lbs. We obtain then as the heat produced, 10,991,000 h. u.; as the heat expended, 6,959,200 h. u., leaving 4,051,800 h. u. in the furnace.

Then to ascertain the furnace temperature:

CO_2 = 733	lbs. × 0.2164	= 158,621
CO = 4,194	lbs. × 0.2479	= 1,040,212
N = 6,749	lbs. × 0.244	= 1,644,560
H = 100.66	lbs. × 3.4046	= 362,644
11,773.66		3,205,037

Then the average specific heat determined as above becomes 0.272, and the average furnace heat 1,280° F.

The amounts of the gaseous products by volume in this case are:

Combustible, 44%	H	= 19,000
	CO	= 53,700
Non-combustible, 56%	CO_2	= 6,000
	N	= 85,800
		164,500 cu. ft.

The total heat units are as follows:

	B. T. U.
H = 100.66 lbs. × 62,000	= 6,612,920
CO = 4,196 lbs. × 4,325	= 18,139,050
Total (151 h. u. per cu. ft.)	24,751,970

This is nearly one-half the value of uncarbureted water gas.

Are these results the best attainable? I think not. In a properly constructed furnace we ought to be able to obtain and maintain 50 per cent. of combustible gases from the total products. With care we can work at a lower temperature than that last obtained, because experience shows that the gases do not leave at furnace heat.

Of course, these calculations are based on theoretically perfect combustion, and no excess of air has been allowed.

Under the best conditions it is possible to decompose 1,500 lbs. of steam to every ton of coal, providing the steam is furnished from an independent source, and to obtain approximately the following results:

	Wt. lbs.	Volume.	Heat units.
Combustible Hydrogen.....	1,666	29,800	10,333,292
" Carb. oxide...	4,194	53,700	18,139,050
Non-combustible Nitrogen..	5,179	65,500	—
" Carb. acid	733	6,000	—
	10,272	155,000	28,472,342

This equals nearly 54 per cent. combustible products and gives 183 h. u. per cu. ft. Can this quality be generated continuously? Experience shows that it can, providing the steam and air are supplied at a sufficiently high temperature. With steam furnished from a separate boiler, at (say) 500 degrees F., no difficulty will be found in producing this quality of gas.

There is still the fuel requisite for supplying the steam to be calculated and allowed for in these results. To produce 1,500 lbs. of steam from water at atmospheric temperature and raise it to 500 degrees would necessitate a consumption of from 1-8 to 1-4-ton of coal; so that our results are reduced to 130,000 cu. ft. of gas, containing 183 h. u. to the foot, or 23,500,000 h. u. to the ton of coal.

The question naturally arises whether it is possible to generate the steam in the same furnace and still maintain the quality of gas.

To do this we have only the waste heat of the furnace, i. e., the sensible heat carried off by the gaseous products, and that radiated through the brickwork, to work with, since we cannot lower the temperature of the furnace without seriously affecting the quality of the gas. As shown, we need 2,500,000 h. u.

Suppose the gases leave the generator at 500 degrees F. above the atmosphere. There are 10,250 lbs. by 600 degrees by .272 equals 1,680,000 h. u., carried away by the gaseous products from one ton of fuel, and allowing 10 per cent. loss for radiation, etc., 1,080,000, making a total of about 2,750,000 h. u.

If it were practicable to utilize entirely this waste heat in producing and superheating the steam, the perfection of the gasification of coal would be reached, for there would be contained in the combustion of the gases 95 per cent. of the heat units contained in the coal itself. By placing a superheater in the take-off pipe, and a superheating coil in the brickwork, a considerable amount of this waste heat becomes available.

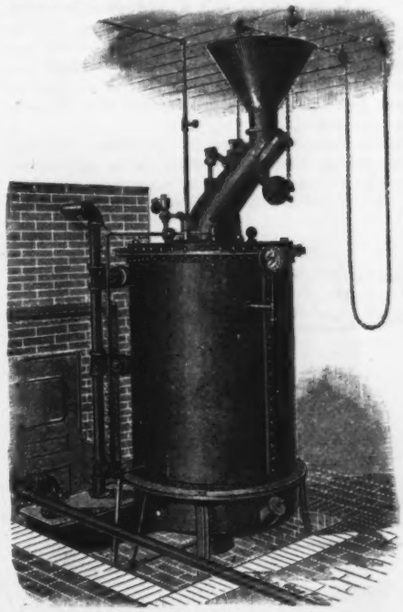
Allowing for all contingencies, I believe it is possible to obtain from 2,240 lbs. of anthracite from 150,000 to 160,000 cu. ft. of semi-water gas averaging 165 h. u. to the foot, which will contain 25,000,000 h. u. of potential heat, or about 83 per cent. of the heat energy of the coal itself. This system offers, in my judgment, the best solution of the fuel gas question. The cost of its production is trifling, and the labor attached to its manufacture (usually a considerable element in the cost of gas) very slight.

With coal at $3 per ton, its cost of production should not exceed 2 1-2 cts. per M. cu. ft. In other words, we obtain 1,000,000 h. u. at a cost of 15 cts. At the present price of Philadelphia city gas, this same quantity of heat costs $2.30.

An objection urged against the use of semi-water gas of this quality is the large size of distribution pipes required to supply a given quantity of heat. This is with reason classed as a minor objection, and water gas proper is then thus described and commented on:

Water gas, made by what is known as the alternate method, consisting in alternating the steam and air blast, will furnish under best conditions not more than 40,000 cu. ft. of gas, containing 300 h. u. per ft., a total of 12,000,000 to the ton of coal. It is composed of carbon monoxide and hydrogen, almost entirely. The producer gas—that given off in blasting the furnace with air—is of too little heating value to convey long distances, and must be burned in large quantities to be effective. It is advantageous to burn this under the boilers for furnishing steam.

The thermal intensity of water gas is very high, while its calorific value is less than half that of coal gas. Its success as a fuel depends solely on one point, the cost of distribution. It can be produced cheaply enough to warrant its introduction, but, unfortunately, the expense incurred in getting it from the holder to the consumer is generally greater than that of manufacturing and putting it into the holder. It is already in use for fuel in several cities, and is sold at 40 and 50 cts. per M. ft. Fifty cts. is too much. Coal gas at $1.25—the price charged in New York City—is just as cheap for ordinary domestic purposes. To compete successfully with coal, water gas containing 300 h. u. to the foot should be sold at 20 cts. per M., at which price



The Kitson Gas Generator.

there will be no difficulty in selling all that a company can produce in every city, except where natural gas is already supplied.

To recapitulate: Of the three methods for converting coal into gas for fuel, viz. by natural or forced draft without steam, by forced draft with steam, and by steam and air alternately—resulting in the generation of producer gas, semi-water gas and water gas, respectively—semi-water gas contains 80 to 85 per cent. of the heating value of coal, and is the cheapest gas, if supplied within a reasonable distance from the place of production.

Producer gas must be burned hot as it issues from the producer, to be advantageous. Water gas contains only about 40 per cent. of the heating value of the coal from which it is produced, and is the most expensive of the three systems.

Not the least of the advantages which semi-water gas, or "steam-jet" producer gas, as it is sometimes called, possesses over water or coal gas, is the ease and simplicity of its production. It can be made in a furnace not much larger than some that are in use for heating dwellings, it requires no storage, is automatic in its production, and can be made in quantities varying from 500 cu. ft. to an indefinite quantity per hour.

The author then describes the apparatus which he has designed for manufacturing semi-water gas, and which has been used for some time to supply fuel for running a gas engine driving an electric light dynamo. The producer is shown in the accompanying engraving, occupying 10 sq. ft. and standing 8 ft. high from floor to top of hopper. This producer will furnish 1,500 cu. ft. of gas per hour, with a coal consumption of 18 to 24 lbs. of coal. The outer sheet is lined with firebrick, leaving within a 21-in. by 3 ft. 6-in. fire space. The interior details would require too much space to describe.

The author goes on to state that with semi-water gas in Korting gas engines of from 2 to 18 HP. he has found no difficulty in developing 1 brake HP. from 85 cu. ft. of gas, equivalent to 1 1-4 lbs. of coal per HP. hour. A well known firm in Manchester, England, is stated to have supplied its works with power for years by means of gas producers and gas engines at a cost not exceeding 1.75 lbs. of coal per HP. hour. A recent test of an Atkinson engine gave 1.11 lbs. per HP. hour. With illuminating gas a consumption of 25 to 30 cu. ft. per brake HP. hour suffices, which is equivalent to a consumption of 15,000 to 18,000 h. u. A 50-HP. steam plant of approved pattern will consume some 45,000 h. u. per HP., which means only 7 per cent. efficiency.

For the gas plant an efficiency of 80 to 85 per cent. is claimed for the producer, and 18 to 22 per cent. for the engine, and absolute efficiency of 14.5 to 19 per cent. for the entire plant. It is not unreasonably claimed that there is a wide field for such power. To avoid the loss by distribution the author states that each block of city buildings might have its own gas works and electric light station to supply both light and heat. He states that he is about making an experiment of this kind in a New York city block.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

X.

(These papers will be republished in book form, and corrections or proper additions are solicited, and can be made at any time.)

We have now sketched the early history of the West Point Military Academy, Rensselaer Polytechnic Institute, Lawrence Scientific School, Sheffield Scientific School, Union College School of Civil Engineering and (in part) the University of Michigan Engineering Department. While it is no part of our plan to sketch the history of all the other schools with equal care, a few notes as to each seem called for, and special circumstances seem to make it advisable to give a somewhat extended sketch of the rapid rise to a prominence of two of the later schools, the Massachusetts Institute of Technology and Sibley College, of Cornell University.

One school which was founded among the very earliest, and which perhaps should have been sooner mentioned, is the Chandler "School of Science and the Arts" of Dartmouth College. This school was founded as early as 1851, in acceptance of a bequest from Mr. Abiel Chandler, of Boston, Mass., and Walpole, N. H., for "a permanent department of instruction in the practical and useful arts of life," specifying especially mechanical and civil engineering, carpentry, masonry, architecture, drawing and modern languages, "together with bookkeeping and such other branches of knowledge as may best qualify young persons for active life." The gift was coupled with the condition that there should be no higher requirements for admission than are taught in the "common schools of New England," but this has been interpreted to cover ordinary high-school courses, so that the requirements are about as high as the average; besides which, Dartmouth enjoys the advantage of having a post-graduate "Thayer School of Civil Engineering," for which a very high standard of admission is required, in accordance with specific requirements of its founder, the late Brevet Brigadier General Sylvanus Thayer, U. S. A., who was graduated from Dartmouth College in 1807 and afterward became a distinguished officer in the Corps of Engineers. His reorganization of the U. S. Military Academy, from 1817 to 1833, which gave that institution its world-wide fame and gained for him the affectionate title of "Father of the Military Academy," we have already sketched. Foreseeing the coming demand for a high order of technical education, especially for the training of civil engineers, he gave to the trustees of Dartmouth College, in 1867, a fund, which he soon afterward increased to nominally $70,000, under stringent conditions. The requirements for admission were to be

very high, including, besides the branches taught in the common schools, algebra, geometry and mensuration, trigonometry, compass surveying, descriptive geometry and geometrical drawing, analytical geometry, differential and integral calculus, elementary mechanics, a full course of elementary physics, elements of inorganic chemistry, meteorology and physical astronomy. To these bookkeeping has since been added. These requirements are specified at considerable length in a "Program" of some 200 octavo pages, which is sent to applicants as a guide in preparation. This necessarily makes the school a "post-graduate" one. The conditions of the gift have also restricted its scope to the branches of "civil engineering" exclusively. Under these circumstances the number of students is limited to a few picked men, and the high standard has secured students of more than usual maturity—the average age being above 23 years at the time of admission. Of the entire number admitted about 46 per cent. are graduates of scientific courses in two colleges, 27 per cent. are graduates of classical courses in three colleges, and 27 per cent. have made special preparation by partial courses.

"About 20% had previous employment in civil engineering, amounting in some cases to several seasons. Of those admitted, less than 3% could not continue for lack of ability, and 16% entered upon professional employment after taking only half of the course, in most cases from lack of means to continue. Out of the entire number of graduates and non-graduates 88% have gone immediately into the practice of civil engineering, and the rest into teaching, astronomical work, meteorology and manufacturing. At present 68% are actively engaged in civil engineering. Of these, 24% are employed in the designing and construction of bridges, two being at the head of the bridge departments of important railway systems, and four the designing engineers for well-known bridge companies; 12% are in private practice, under their own names, and the others are engaged in railroad, hydraulic and mining engineering. Five are professors of civil engineering, five are in various lines of business, one is in the ministry, one is astronomer at the U. S. Naval Observatory, one is professor in the Signal Service, five are deceased."

The course of study and practice extends through two years, under the direction of the senior professor and one associate, who give their time exclusively to this work. The Thayer Post-Graduate School has not been, and perhaps never will be, a large one, as it is somewhat removed from the great centers of engineering activity, but its graduates show a high average of success in their subsequent records.

The Chandler School has always conferred the degree of B. S. only upon all its graduates, the first of whom were graduated in 1854, but it distinguishes between its engineering and other graduates. Out of 343 graduates up to and including the class of 1886, 165 only had taken the engineering course, and are shown in the tables which are to follow.

There is, in addition, still a third scientific school, a "New Hampshire College of Agriculture and the Mechanic Arts" connected with the school, and these three departments have each one or more professors of civil engineering, or four in all between them, to teach a very small number of students in the aggregate.

It is perhaps unfortunate for the college that these three schools cannot unite their forces and endowments, striking an average between their very high and pretty low requirements and having a common faculty; but this could only be done by breaking the letter to fulfill the spirit and intent of the deeds of gift, and would require legislative authority.

Could this be done, however, it should result in a very strong institution, especially if it retained as its motto these golden words from the catalogue of the Thayer school, which we could wish that every engineering school would adopt and make prominent:

Those who desire to study civil engineering are strongly urged to take a full collegiate course, either on a "classical" or a "scientific" basis. In addition to the knowledge of the special preparatory subjects above named, the student will thus obtain a broad and liberal training, which, in civil engineering, as in other professions, constitutes a preparation of the highest value.

It does, indeed. The graduate who knows nothing but engineering, and has no smattering of letters and of general culture to aid him, has an up-hill road before him.

The University of Michigan engineering department might, in a certain sense, be said to be the first one ever created in this country. In the Act of Legislature of the State, dated March 18, 1837, "To provide for the organization and government of the University of Michigan," Section 8 reads: "The University shall consist of three departments;

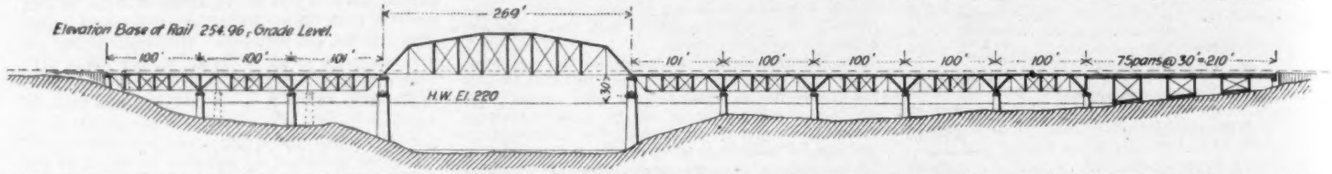


FIG. 1. GENERAL ELEVATION OF THE KENTUCKY RIVER BRIDGE AT IRVINE, KY., R., N. I. & B. R. R. JOHN H. PEARSON, CHIEF ENGINEER. THE MASSILLON BRIDGE CO. AND THE SCHULTZ BRIDGE CO., CONTRACTORS.

1. The department of literature, science, and the arts; 2. The department of law; 3. The department of medicine. In the several departments there shall be established the following professorships . . . . . one of civil engineering and architecture." In date of first graduates, however, the University of Michigan stands as the sixth engineering school.

In 1852-3 civil engineering is mentioned as a study. In November, 1853, Mr. Alexander Winchell was appointed professor of physics and civil engineering. In 1855, Mr. W. G. Peck, a graduate of West Point, at the head of the class of 1844, was made professor of civil engineering. Prof. Peck resigned in 1857, and was succeeded by De Volson Wood, first as assistant professor and afterwards as professor, in 1859. Prof. Wood resigned in 1872, to accept an appointment at the Stevens Institute of Technology, and was succeeded by Prof. Chas. E. Greene. In 1857 six scientific students are noted as studying civil engineering in their senior year; but it was not until Dec. 22, 1858, that a civil engineering course was added by Board of Regents to the curriculum, and the degree of C. E. authorized. The first degrees (two in number) were conferred in 1860. The degree was changed later to B. S. (in 1882) following a recommendation made by Prof. Greene in 1879; and "C. E." was made an advanced degree, given after further study and responsible professional work for one year.

Profs. Peck and Wood, with Prof. Trowbridge, who was for a short time with Prof. Peck, must have organized the department well, as the school early obtained, and has ever since retained, a high rank among engineering schools.

The Polytechnic Institute of Brooklyn, which was the seventh engineering school to get into working order, has always been an institution of local rather than national fame, and of the academic rather than the collegiate type. Since its reorganization in 1889, however, it has assumed a full collegiate organization, and before that time it had an excellent standing as a school of science, since its first scientific graduates appeared in 1889. Its course before 1889, however, was not fairly comparable in thoroughness with that of the more prominent engineering schools. Since that date it has been much strengthened and now compares favorably with the average. The institute was first founded in 1854 as a "Collegiate and Polytechnic Institute," but the word "Collegiate" has been dropped out, though classical studies are still pursued in the academic (preparatory) department, so far as is necessary to prepare students for college.

The Pennsylvania Military Academy was the next school to establish a distinct course of study in engineering, but it was not then, and has not since become, an engineering school of such high standing and national repute as to make it needful for us to sketch its early history. The next engineering school of prominence to be established, after the University of Michigan, was the Columbia College School of Mines. While ninth in order of time in the complete list, it had only three predecessors

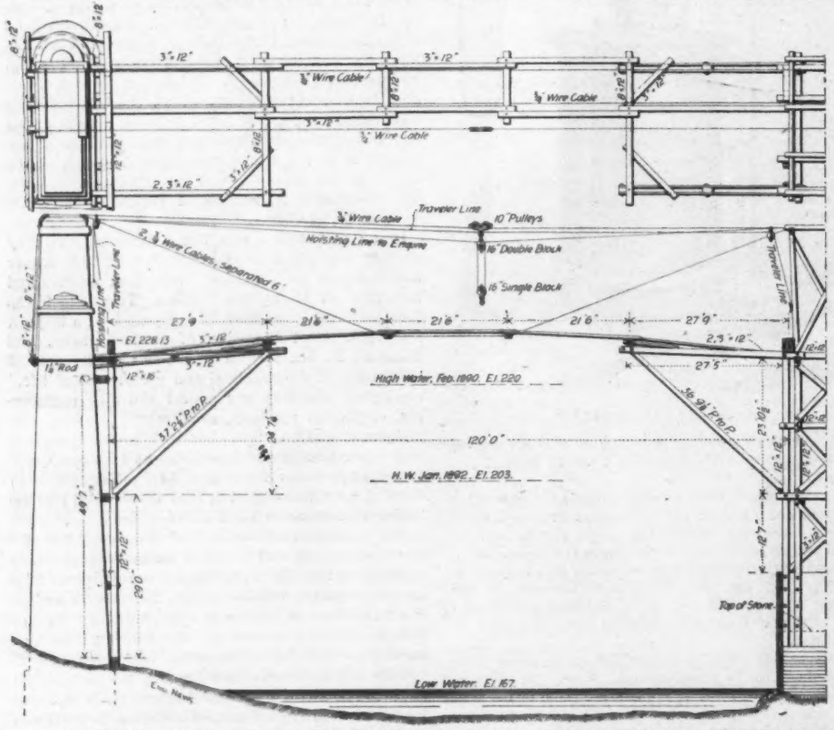


FIG. 2. COMBINED CANTILEVER AND SUSPENSION FALSEWORK USED IN ERECTING TEMPORY HOWE TRUSSES.

among the schools which now enjoy approximately equal prominence, Troy, Yale and the University of Michigan.

The Columbia College "School of Mines" is now in fact a general engineering school, though the old name remains the official title of the department. It was organized in 1863,and was the first mining school organized in the United States, and the first technical school of any kind to make instruction in mining engineering a distinctive feature, so far as we have learned. Prior to that date would-be mining engineers had to go to Germany or France for instruction. In 1864 the school was first started and its first graduates were in 1867. It had not been many years in existence, however, before it began to be seen that its course was equally adapted for training any kind of other engineers, except for the last year or two, and by gradual expansion it has now eight regular courses, civil, mining, sanitary and electrical engineering, architecture, metallurgy, chemistry and geology, and the graduates in mining engineering are but a small percentage of the whole. It needs only to add a course in mechanical engineering and the school will cover as broad a field as any other, and a broader field than most. The admirable training in mechanical engineering which is offered at the Stevens Institute, across the North River, may retard this result, but it seems a tolerably safe prediction that the same causes which have expanded the one original course into eight, will in the end expand the eight courses into nine.

This school was also the first in the country to be established and pushed forward to success by allotments of revenue from existing foundations, without tender of any gifts from a founder as an inducement, or any support from public funds. The Union College department of civil engineering was its only predecessor of this kind, and that has never been so prominent a school. As such, the school reflects great credit upon the wisdom and foresight of the college management, for it has moved steadily and rapidly forward, and has undoubtedly contributed much to the general standing of the college. The building which the school now occupies was erected in 1874 at a cost of $150,000. The approaching removal of the entire college to a new and commanding site in upper New York is likely to give it an impetus in all its departments, and the School of Mines will doubtless share in the general prosperity.

The two engineering schools next formed were the Massachusetts Institute of Technology and the Washington and Lee University in Virginia, whose first graduates appeared in 1868, one year after the first graduate from the Columbia School of Mines. The "M. I. T." assumed from the very first a leading position among our engineering schools, and though it has had its ups and downs, it graduates to-day about twice as large a class as any other in the country, Sibley College at Cornell alone excepted*; and as its standard of requirements is also among the highest, it may fairly be called to-day our leading engineering school, if any one school can be called such. Its early history is also among the most interesting of all, and demands a separate article.

* Sibley College graduates, as an average, about two-thirds as many as the M. I. T. and more than the M. I. T. graduates in a corresponding number of separate courses.

ERECTING THE KENTUCKY RIVER BRIDGE AT IRVINE, KY.

By John H. Pearson. *

The bridge recently erected across the Kentucky River at Irvine, Ky., the general outlines of which are shown in Fig. 1, has a channel span of 269 ft., two spans of 101 ft., six spans of 100 ft., and a viaduct approach of 211 ft., making a total length of 1,282 ft. between abutments. The height of the structure from low water to base of rail is 87 ft., and the difference between high and low water is 52 ft. There are nine piers and two abutments, besides the six pairs of viaduct pedestals. The masonry in these piers, which are considered one of the finest pieces of work in the state, was built by Mr. John Mitchell, of Louisville, at a cost of less than $9 per cu. yd., which for the class of work was exceedingly low. The lowest other bid was $11.50 per yd. The stone is limestone with traces of rock oil and is very durable.

The superstructure is of the best workmanship and materials. The channel span is of iron and steel; six of the other spans are combination wood and iron of the Thacher type, and there are two Howe truss spans and a wooden viaduct. The Schultz Bridge Co. of Pittsburg had the contract for the channel and two 101 ft. spans, and the Massillon Bridge Co. of Massillon, O., for the six 100-ft. spans.

The Kentucky River runs between high perpendicular cliffs in a narrow gorge, and is a very treacherous stream to bridge in the winter months, on account of its sudden rises of from 30 to 50 ft. in 48 hours. Figs. 4 and 5 are from photographs of the river at high and low water. Fig. 1 shows the contrast between the highest and lowest stages in the river. Besides this, the river carries a large amount of drift and great number of saw logs and rafts, while an occasional steamboat passes. It was, therefore, considered too great a risk to erect the channel span on ordinary false work, especially as the Kentucky Union R. R., which crosses the North Fork at the head waters of the Kentucky River, had its channel span washed out twice before its present bridge was made secure. For this reason the writer decided to use what he considers, if not an original scheme, a very novel but safe plan for crossing the channel temporarily and providing for the erection of the permanent span. He wishes to call the attention of other engineers and bridge builders to the merits of this plan for use in similar cases.

* Chief Engineer of the Richmond, Nicholasville, Irvine & Beattyville R. R.

The span in the clear from face to face of channel piers at bottom or low water line is 259 ft. In the center between the piers a substantial crib of 12-in. timbers was erected, the crib measuring 42 ft. long, 17 ft. wide and 21½ ft. high. It was without a bottom and had a 90° cut-water on the up-stream end. This crib was filled in with loose stone for a depth of 11 ft. above its bottom and riprap was dumped around its sides and ends. It was further weighted with 1,000 wheat sacks filled with sand, which was plentiful and cheap, while stone was costly and scarce at the bridge site. Wheat sacks were used on account of being tight woven, so that the sand could not wash out when the sacks were submerged. The crib had four solid bulkheads for half its height and two for the other half, and two solid ends.

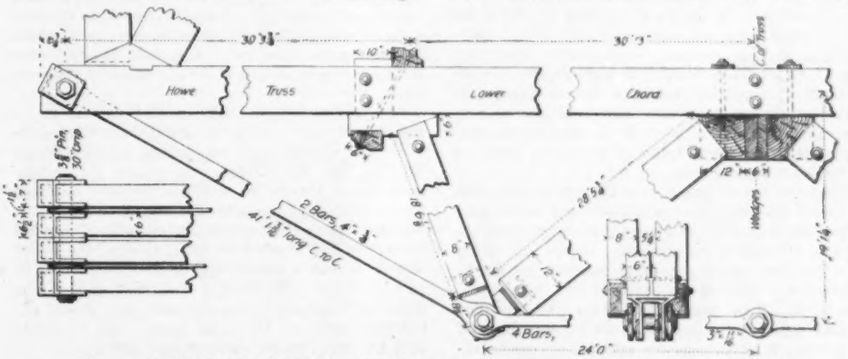


FIG. 3. DETAILS OF TEMPORARY TRUSSING OF LOWER CHORD OF HOWE TRUSS.

On top of the four lower bulkheads and the lower half of the ends a tower was erected 40 ft. high above the top of the crib. It was made of 12 × 12-in. posts, 20 in number, 16 of which, in groups of 4, were plumb and the other 4 battered in toward the top from each end of the crib, with an inclination of 2 ins. per ft. The posts were all substantially braced together, and they ran down into the crib 10 ft., where they were bolted to the two upper bulkheads, the top half of the crib and the sides, making the crib and tower all one firm and compact structure capable of withstanding the highest rises of the river, especially when further loaded with the weight of the two 122-ft. Howe truss spans which it carried.

Against the channel side of each pier and securely fastened thereto a substantial timber frame was erected, consisting of four 12 × 12-in. and two 12 × 14-in. posts, all plumb and firmly braced. The channel

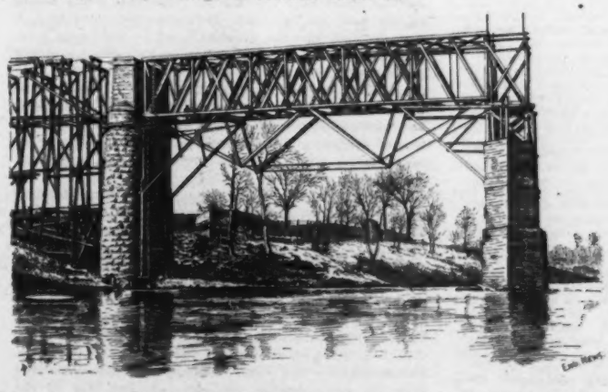


FIG. 4. HOWE TRUSS COMPLETED OVER HALF OF CHANNEL, LOW WATER IN RIVER.

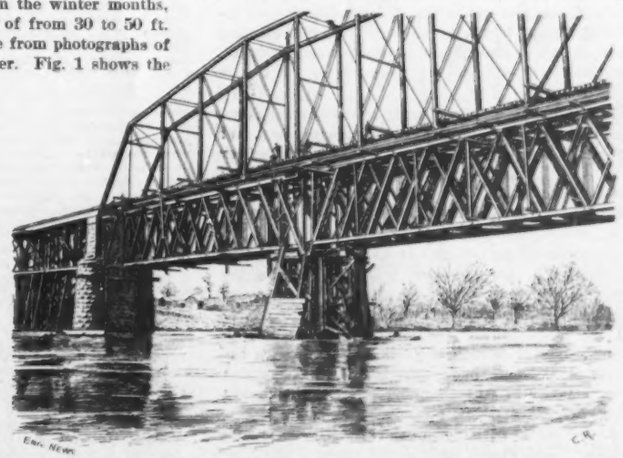


FIG. 5. PERMANENT CHANNEL SPAN ERECTED ON TEMPORARY HOWE TRUSSES, RIVER AT 35-FT. STAGE, MARCH 25, 1892.

was thus divided into two openings of 122 ft. each, after taking out 15 ft. for width of tower, out to out. To cross these openings, two deck Howe trusses were provided by the Massillon Bridge Co. These trusses were designed to temporarily carry the trains as well as to form the false work for the erection of the permanent channel span. After its erection the trusses were to be removed and put up permanently to form two of the 100-ft. shore spans mentioned above.

The novel part of the work consisted in raising these two 122-ft. temporary Howe truss spans without any of the usual false work. To erect the first span four substantial but light brackets were erected, two attached to the tower and two to the pier. They are shown in Figs. 2 and 4. The horizontal part of each bracket consisted of two pieces of 3×12-in. timber, and the inclined post or brace of one round timber 8 ins. diameter at small end. Each pair of brackets was separated one from the other 22 1-3 ft., c. to c. They were connected together at their outer ends by an 8×12-in. stick on which the Howe truss lower chords temporarily rested while being packed and trussed, these chords being separated 16 1-3 ft., c. to c. The inclined braces were each 37 ft. long. Each pair of brackets projected over the stream from face of tower and pier to center of the 8×12-in. stick 29 ft., leaving an opening of 64 ft. between centers of the 8×12 sticks on the ends of the brackets.

From the top of one pier to the top of the other and over the tower two new ¾-in. wire ropes were swung 6½ ft. apart and dropping down to about the level of the tops of the brackets. Upon these cables two 8×12-in. sticks were laid, driving the 64 ft. between the ends of the brackets into three openings of 21 1-3 ft. each. The 122-ft. span was thus divided into five spans—two of 29 ft. and three of 21 1-3 ft. With the support afforded by the brackets and the cables the lower chords of the Howe trusses were put in place and packed; and with some old eye-bars an inverted queen-post truss was built below them, strong enough to support safely the weight of the Howe truss top chord and the intermediate bracing.

The two lower Howe truss chords thus trussed, and with the permanent lateral bracing put in between them, formed a complete suspension truss bridge of 122-ft. span, on which the remainder of the Howe truss was safely erected. As soon as the lower chords were thus trussed, however, the brackets and cables were no longer needed and were removed for use in the second span. In like manner, as soon as the first Howe truss was completed, the temporary truss rods were removed for use in the second span.

It required one-half day to put up the brackets, one-half day to properly arrange the three wire ropes, and one and a half days to pack and truss one chord, or three days to pack and truss both chords. It also required three days to finish the remainder of the Howe truss span, making a total of six days to erect one 122-ft. span.

As proof of the wisdom of adopting this plan of erection, it is only necessary to say that during the erection there were two freshets in the river, one of them a 35-ft. rise, and either of which would have at once taken out any ordinary post false work, although they did not in the least interfere with the work as it was conducted. During the erection over 50,000 logs and a number of rafts, boats and great quantities of drift went past the bridge.

At the outset of the work a ¾-in. wire rope was stretched taut across the channel opening from the top of one pier to the top of the other. Upon this rope a trolley with two 10-in. wheels was placed, and from it double and single 16-in. iron blocks were suspended with two standing lines, using 1-in. manila rope. This traveler did all the hoisting in the construction of the crib, tower and spans. The trolley and tackle were connected in a simple manner, and the trolley was worked like a traveler carriage on a horizontal boom derrick. The load was easily moved up or down, or in or out clear across the stream with very little power.

The end shoes used in the temporary trussing of the lower chords are shown in Fig. 3. Each lower chord was made up of four pieces of 6×12-in. timber. A 4-in. hole was bored entirely through the four pieces near the ends of the chord, and each piece had a U shaped shoe made of 8×1¼-in. bridge iron with a 3⅝ hole bored through each prong. These shoes straddled the ends of the chords so that the holes came opposite. A 3⅝-in. pin 28 ins. long passed through each shoe, the four chord pieces and the two suspension eye-bars, making a very secure end connection.

The work of erecting the bridge was begun on Dec. 1, 1891, and a train of passenger cars had to be run across the river into the town of Irvine before Feb. 28, 1892, or the railroad company would forfeit one-half of the Estill County subscription of $100,000. From Dec. 1 to Feb. 28 is a very short time to finish a bridge of this magnitude; but if the work was so far finished as to permit a train to use it by the time designated, even though it ran over false work, the subscription would be earned.

It was, therefore, decided to use strong false work so that it would safely carry a train, and for this reason the two Howe trusses were erected, otherwise the two suspension trusses without the top chords and the web members would have been amply strong to have supported the permanent channel span upon during erection, and the Howe trusses could have been erected in their permanent places at once.

The first passenger train crossed the bridge on Feb. 20, thereby earning the Estill County subscription. The channel span was swung off its wedging on Feb. 24. The bridge was opened for regular business on March 28, and was formally accepted by the receiver of the railway company on April 2.

If this manner of erecting a span is of especial interest to any member of the profession, the writer will be pleased to answer any questions regarding it, as he believes it is the first time that such a long span has been safely erected with such simple appliances, and that the same plan could be safely used for longer spans, up to at least 300 ft.

THE NEW YORK & NEW JERSEY BRIDGE COMPANY.

The Senate Committee on Commerce decided last week to make an adverse report on the bill for a bridge over the North River at New York, pending in behalf of the New York & New Jersey Bridge Co. The following is the press report of the debate:

Senator Hiscock entered an earnest protest against the passage of the bill, which his colleague Senator Hill had favored. He backed up the protest of Mayor Grant, the New York Common Council and the Chamber of Commerce. As to the power of Congress to give the proposed North River Bridge Corporation the right by condemnation proceedings to acquire property necessary for approaches to the bridge, Mr. Hiscock said that he had no doubt that under the interstate commerce clause of the Constitution Congress could grant such rights along the lines of traffic, but, in his opinion, the only purpose and object of the pending bridge bill was in one form or other to sell a franchise, or impede the construction of the first bridge (the Lindenthal North River bridge, which Congress has heretofore authorized to be built), and its passage was wanted as a measure of coercion on some other project. If Congress passed this second North River bridge charter, neither of the proposed bridges would be built within the lifetime of the members of the committee, unless one company bought up the other.

Mr. Vest suggested that the act provided for a forfeiture of charter if the bridge was not built within five years, and Senator Hiscock replied that after that time there must be litigation, and every one knew the trouble in forfeiting charters. He did not want to make charges against gentlemen, but the first bridge had solid, responsible men behind it who meant to push it, and he had reached a different conclusion as to the second bridge.

Senator Vest said that that had at first been his impression, but he had asked Senator Hill directly if it were a "snide" affair, and the Senator replied that he knew the people were entirely solvent and in earnest.

Mr. Hiscock replied that he was not going to take issue with his colleague, but Mr. Hill had been more fortunate than himself in his contact with those people.

Senator Gorman—Mr. Hewitt is connected with it.

Senator Hiscock (emphatically)—He is not connected with it. All Mr. Hewitt wrote was that he favored a bridge across North River. If Hewitt, Cooper, and men of that character came here and said they would put their shoulders to the work of building the bridge, it would modify my opinion very greatly.

After Mr. Hiscock was heard, the committee in a short secret session decided by practically a party vote to recommend that the North River Bridge Bill be not passed.

The New York "Times" comments on the committee's action as follows:

The Senate Committee on Commerce has decided upon an adverse report on the New York & New Jersey Bridge Bill. It is rather strange there should have been a party division in the committee on the question. The New York state charter for this bridge was logrolled through the legislature through the efforts of a member of the Assembly from Orange Co. It never came from any demand of the people of this city and was never backed by capitalists who proposed to build a bridge. It was merely a speculative venture to make money by disposing of the charter and bringing in a combination of railroads to make the scheme profitable. The act of the legislature showed this purpose upon its face, and never had respectable support. The privilege of building approaches and railroad connections involved the most extraordinary latitude for interfering with public and private rights. A combination was effected with an old New Jersey charter which had been long dormant. The whole scheme is an outrageous one, to which the people and authorities of this city are opposed. A bridge across the Hudson River is desirable, but by far the best promise of its construction lies in the national charter for the Lindenthal enterprise, and the Green-Swan speculative scheme is a mere obstruction to be bought out of the way.

GATES ON FORCE MAINS. (a)

A curious accident recently happened on the plant of the Hackensack Water Co., of Hoboken, N. J. The main pumping station of the company is at New Milford on the Hackensack River. From this station water is forced through two lines of mains, lying one on the east and the other on the west side of the Hackensack Valley. One main is 20 ins. in diameter, and 15 miles in length, from the pumping station at New Milford to the reservoir at Weehawken. The other line is 24 ins. in diameter, and 16 miles long, between these two points.

There are four pumping engines at New Milford. All of them are of the duplex, direct acting type, and were built by Henry R. Worthington. One of these pumps has a capacity of 10,000,000 gallons in 24 hours. This pump is, however, not quite ready for service. The next largest pump has a capacity of 5,000,000 gallons in 24 hours. Both of these pumps have the high duty attachment. The other two pumps have each a capacity of 3,000,000 gallons in 24 hours and are of the ordinary low duty type. The two 3,000,000-gallon pumps are usually employed to supply the 20-in. main, and the 5,000,000-gallon pump to supply the 24-in. main. For convenience of operation, the by-pass or connecting gate at New Milford is usually kept shut, thus separating the 20 and 24-in. mains.

At 8 p. m. on May 3, 1892, the rod connecting the water plunger with the cross-head of the compensating cylinders on the south side of the 5,000,000-gallon engines and the cross-head, together with the plungers in the compensating cylinders on the high duty attachment, broke simultaneously. At the time, the 5,000,000-gallon pump was forcing about 4,500,000 gallons of water per day through the 24-in. main under 102 lbs. pressure, and one of the 3,000,000-gallon pumps was forcing 2,225,000 gallons of water per day through the 20-in. main under 91 lbs. pressure. Immediately after the accident occurred, the by-pass or connecting gate was opened, and the second 3,000,000-gallon pump started, but to our surprise, we found that we were unable to force more than 3,500,000 gallons through both mains at 110 lbs. pressure per sq. in., where previously we had been supplying 6,750,000 gallons through these two mains under a much lower pressure.

The two lines of force mains were immediately examined. The air cocks showed no collection of air in the mains, and the gates seemed to be all right. An inquiry into the pressure at the service pipes of consumers along the line of the force mains was then instituted, which resulted in the discovery that between two adjacent localities there was a marked difference in the pressure obtained from the same main. As this could only result from something being wrong at the gate on the main between those localities, it was decided that the trouble must be with this gate. The gate is a vertical one, having two disks attached to the valve stem, and it is operated in the usual manner. When the gate was taken apart, it was found that the lugs which connected the disks to the stem had broken off, and the disks had dropped to the bottom of the gate. This closed the entire opening in the 24-in. main, while under a pressure of over 100 lbs. per sq. in.

The shock or strain that was thus suddenly brought upon the engines and the mains can only be imagined. The curious thing about it, and what puzzled us, was that as far as could be ascertained by opening and closing of the gate, it seemed all right. This was probably due to the fact that one disk of the gate still remained attached to the stem and could be moved up and down by the valve stem, although, of course, it had no effect on the flow of the water after the other disk had dropped down into the socket of the gate. Fortunately for the water company, the rod connecting with the compensating cylinders on one side of the engine, together with its cross-head and attachments, gave way under the excessive strain thus suddenly brought upon them by the stopping of the flow of water, and, as the mechanism for operating the steam valves of the other cylinders is attached to this cross-head, the steam valves remained unopened, and the engine instantly stopped of itself. If it had not stopped the mains must certainly have been ruptured.

As above stated, the break occurred at 8 p. m., May 3. The Worthingtons were immediately notified, and

(a) A paper by Mr. C. B. Brush, C. E., Superintendent Hackensack Water Co., read before the American Water-Works Association, at New York, May 19, 1892.

at 5 p. m., May 6, the broken parts had all been replaced, and the engine was again running in good order, and it has been in satisfactory operation since that time.

Most of the gates on our force mains are horizontal geared gates, The gate in question was placed vertically because the pipe was at that point at a considerable depth below the surface of the ground. The result of our experience in this matter, however, has convinced us that large vertical gates on force mains are undesirable.

In this connection, it may be pertinent to say that the location of gates on force mains should be on summits rather than, as is usually the case, in depressions. Gates require and should receive constant attention, and this attention is much more readily given, and in fact, generally only can be given when the gate is free from water pressure on either side. The water pressure is always relieved more easily from summits than from depressions. This fact may seem self evident, and hardly worthy of consideration, but if it is not considerend, a large amount of unnecessary time, labor and money may be wasted.

A portable bridge for military purposes has been tested at the Cockerill Works, Seraing, Belgium, The bridge was 100 ft. span, built up of straight wrought iron members, each piece weighing not more than 90 lbs. The bridge is intended to be erected on the bank and pushed forward. A temporary extension of 58 ft. is built at the front end, which will reach the opposite bank before the middle of the bridge proper has left the bank. The bridge is the invention of M. Brochokl.

At the nickel mines in New Caledonia the company has introduced Japanese labor, and has established a colony of 600 of these laborers, in consequence of the difficulty of securing and retaining efficient labor.

A railway from Acre to Damascus, in Syria, is projected, and a concession has been granted to Mr. J. R. Pilling, of Effingham House, London, England. The line is to be standard gage, 120 miles long, of which 110 miles will be across the plains. The final location is said to be in progress. The cost of construction and equipment is estimated at $10,000,000.

A uniformed corps of street sweepers has been started in Chicago. There are about 70 men, who will work in pairs, one man sweeping up the dirt and the other shoveling it into a barrow.

A steam hopper dredger with a capacity of 3,000 tons, and able to dredge 4,000 tons per hour, is being built for work on the Mersey River bar at Liverpool, England. She will dredge to a depth of 28 ft. below low water.

A large iron mining company for New Mexico is being organized, according to the daily papers, and will develop the iron ore of the Hancver valley. The ore is said to be well adapted for Bessemer steel purposes. Among the men interested are said to be W. Harriman, of New York; F. Crocker, Vice-President of the Southern Pacific R. R., and John Brockton, of El Paso, Tex.

A continuous tin plate machine has been put into operation in Philadelphia by the American Tin Plate Machine Co., Twenty-first St. and Washington Ave. The black sheets are taken from the pickling tank and fed, one after the other, into the machine. As the sheets pass along they are scoured with sand, and brushed clean by revolving rolls, washed with water and dried by steam heat. The ends of the sheets are then fastened together to form a continuous sheet, and this is passed through a pot of flux and then through the tin bath, which is kept covered with palm oil. The machine is at present working on terne plates. It is stated that it can turn out 100 boxes per day of 10 hours. It is intended, however, to market the plate in continuous rolls, which will save the expense of boxing and will be of especial advantage for roofing purposes. Mr. Samuel Y. Buckman is the inventor of the machine.

The International Railway Congress, which is to be held at St. Petersburg, Russia, and which was referred to in our issue of March 26, will not be held in June, as previously noted, but will last from Aug. 20 to Sept. 3.

A fast run was made on the Pittsburg, Fort Wayne & Chicago R. R., on May 14. The Columbian express, a train of 6 cars, 3 of them Pullmans, made the run from Fort Wayne to Chicago, 128 miles, in 2 h. 58 min. The schedule time is 4 h. 15 min. From Fort Wayne to Plymouth, 84 miles was made in 70 minutes, according to press dispatches.

The Citizens' Water Co., of Denver, Colo., has let contracts for a 34-in. redwood water supply conduit, 23 miles long, paralleling its 30-in. conduit from the South Platte River. The contractors and prices are as follows: Ditching, J. B. Henry, $25,000, or about 21 cts. per lin. ft.; 2,500,000 ft. of redwood timber, Pacific Redwood Lumber Co., San Francisco, Cal., for $100,000, or $40 per thousand; 750 tons of steel rods, Oliver Iron & Steel Co., Pittsburg, Pa., for $75,000. It is reported that the conduit must be completed by Aug. 1, and that, when completed, the company can furnish 30,000,000 gallons per day.

The great Memphis bridge has now been opened to public use with all the proper and usual ceremonies, a jumper having jumped from it at 4 p. m., May 15, 149 ft., and came out alive.

The railway gage question in India does not appear to be given proper attention by the higher authorities. The Rohilkund & Kumaon Ry. is a meter gage line, separated from two meter gage systems by 45 and 39 miles of broad gage, but in spite of repeated application, the Secretary of State for India has failed to grant the necessary permission for the laying of a third rail to connect these lines and thus avoid the present break of bulk and change of cars for through freight and passenger traffic.

A 14-in. armor plate was tested at the Indian Head proving grounds on Saturday by three shots from a 10-in. gun. The projectile weighed 500 lbs., and a powder charge of 140 lbs. was used, giving a muzzle velocity of 1,410 ft. per second. All three shots rebounded, and the deepest penetration was 14 ins., so that none of the shots injured the backing. One of the projectiles, an imported Firth, broke up, while the American projectiles were uninjured. The plate tested was of nickel steel, and is one of the lot just completed for the battleships "Indiana" and "Massachusetts."

A novel race against time on bicycles was made last week under the direction of the War Department, from Chicago to New York. The entire distance by the route taken was 975 miles, and the time made was 109 h. 5 min., an average of 8.94 miles per hour. The start was made from Chicago at noon Wednesday, relays were arranged for at intervals of 5 to 25 miles, about a hundred riders participating in the contest, and two or three riding over each section to minimize delays by accident. The schedule time arranged for the trip was 94 hours or 10.37 miles per hour, but nearly continuous rains and roads ankle deep in mud over much of the route made fast running impossible. It is a significant commentary on the relative merits of English and American roads that a single English bicycle rider last year rode from John O'Groat's, at the north end of Scotland, to Land's End, at the southern extremity of Wales, a distance of 875 miles, in a little over four days, which is at the rate of about 8.75 miles per hour, or nearly as good time as was made in the Chicago-New York run, riding in relays averaging 13 miles per man.

The hot water foot warmer and the rug with which the British traveler comforts himself on his winter journeys in his unheated railway cars may yet become obsolete through the zealous missionary work of an American car heating company. Col. Wm. G. Rice, of the Consolidated Car Heating Co., has been spending some time in England lately, and we understand, endeavored to secure a trial of his company's car heating appliances on English cars.

The hearings before the Supreme Court Commission appointed to report on the feasibility of the plans recommended by the New York City Rapid Transit Commission, still continue and enable a large number of persons to display their ignorance of the engineering questions which are before the Commission. The majority of those who have testified are real estate owners, whose opinions on the questions at issue are practically valueless. A few builders and architects have been examined, but really important expert testimony on the question at issue has been almost wholly absent. The hearings are soon to be closed, and an early decision from the Commission may be expected.

A great intercepting sewer along the Pawtuxet River is proposed, and a resolution has passed the Rhode Island House of Representatives authorizing the Governor to appoint a commission to determine the practicability of the scheme. The city of Providence takes its water supply from the Pawtuxet, and the sewer is intended to stop the pollution of the river by the factories and villages along it. The cost of the work would probably be divided between Providence and the villages using the sewer.

The bill before the U. S. Senate, granting a charter to the New York & New Jersey Bridge Co., has been killed in committee, after a discussion, reported elsewhere. Senator Hiscock, declaring that in his opinion the sole purpose of its promoters was, in some form or other, to sell their franchise or impede the construction of the Lindenthal bridge, which was chartered by Congress two years ago.

The largest timber dry dock in America is to be built at the Brooklyn Navy Yard, and bids have been called for, as announced in our last issue. The general dimensions of the dock will be as follows:

	Ft.
Length on coping level along axis of dock from inside of head to head of inner abutment	560
Length inside head to inner gate sill	530
Length inside head to outer end of table	625
Width on coping at head	94
Width on coping at body	151
Width on coping at abutment	105
Width on floor of dock at head	27
Width on floor of dock in body	64
Width on floor at outer end of table	116
Depth from top of coping to working floor of dock	35
Draft mean high water over sill	28

The passage by Congress of the bill giving American registry to the "City of Paris" and "City of New York" is followed by the introduction of a bill permitting American registry on the same terms to vessels owned by the American Steamship Co. That is, every vessel owned by the company of at least 7,000 tons burden and capable of speed of at least 15 knots per hour, may be admitted to registry, provided the company, on making application for registry, will show that they have contracted to build in an American shipyard a vessel of equal or greater tonnage. The capitalists who propose to organize the American Steamship Co. are Austin Corbin and others. It is claimed that this bill means the carrying out of a long cherished scheme of Mr. Corbin's, for the establishment of a line of fast passenger steamers, sailing from the eastern end of Long Island.

Gas is to be piped to New York city from Long Island through a tunnel under East River by the East River Gas Co. Emerson McMillin is President and Ghas. M. Jacobs, 192 Broadway, is the Engineer. Surveys are now in progress.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

ROCKAWAY VALLEY.—The Rockaway Valley & Morristown Extension R. R. Co., has been chartered to build the proposed extension of this road from Mendham to Morristown, N. J.

BALTIMORE & OHIO.—Work will soon be commenced on the proposed terminal improvements at Staten Island. The work will include the construction of a new station and ferry house and three ferry slips, and other terminal improvements.

BALTIMORE & DRUM POINT.—A new company has been formed by the purchasers of this partly graded railway from Baltimore to Drum Point, Md., which will complete the line.

GOUVERNEUR & OSWEGATCHIE.—This company, whose incornoration was noted in our issue of April 21, has awarded the contract for building its proposed line from Gouverneur to Edwards, N. Y., 15 miles, to Moffett, Hodgkins & Clark, Syracuse, N. Y.

CONCORD & MONTREAL.—The contract for grading the 3¼-mile extension from Jefferson Station to Jefferson Hill, N. H., has been let to Ward & Douglas, of Barre, Vt.

MANISTEE & NORTHEASTERN.—All but about one mile of the grading has been completed on the extension from Cedar River to Traverse City, Mich., 14½ miles, and 7.11 miles of track have been laid.

CAMMAL & ENGLISH CENTER.—A force of about 140 men are at work on this railway from Cammal to English Center, Pa., about 15 miles. It is expected to have 7 miles of track completed in July. The road is being built to develop a rich timber section.

LAKE ERIE & DETROIT RIVER.—The contracts for building the 23-mile extension of this railway from Leamington to Merlin, Ont., have been let, Flock & Babcock, Windsor, Ont., have the contract for the culverts and bridges and Baird & Taylor, of Leamington, Ont., for the grading. The route is through a level country; maximum grade 10½ ft. per mile and maximum curve 1°.

RICHFIELD & NEW YORK.—The contract for building this road has been let to the Lehigh & Pittsburg Construction Co., 29 Broadway, New York city. The road is projected to run from Port Chester, N. Y., to Danbury, Conn., a distance of 30¼ miles. All the surveys were completed some time ago and a considerable amount of grading has been done. The route is through a hilly country and the work will be quite heavy, there being about 250,000 cu. yds. of rock work. It is intended to begin construction immediately and the construction company will soon be ready to sublet the work.

Projects and Surveys.

KONKAPOT VALLEY.—Chartered in Massachusetts to build a railway from New Marlboro, Mass., down the Konkapot Valley to the Connecticut state line. Henry L. Langham is one of the incorporators.

KEYSTONE NORTHERN.—Chartered in Pennsylvania to build a railway from a point on the Pittsburg & Western R. R., near Wurtemburg, Pa., to Rose Point, Pa. Pres., F. L. Stephenson, Philadelphia.

TOMHICKEN, MILNESVILLE & EASTERN.—Proposals have been received for grading this proposed railway from Tomhicken to Milnesville, Pa., 8 miles, and contracts will soon be let. J. I. Hollenbeck, Ch. Engr., Milnesville, Pa.

WEBSTER & PASCOAG.—A project is on foot to build a railway from Webster to Pascoag, R. I., about 14¼ miles.

OTTAWA, WADDINGTON & NEW YORK.—This company and the Ottawa, Morrisburg & New York Ry. Co. have introduced bills for renewal of their charters into the Canadian Parliament. A press dispatch sums

up the history of the two corporations as follows: "In 1882 a charter was granted for the construction of a railway from Ottawa, Ont., to Waddington, N. Y. It was not until 1884, however, that power was given to bridge the St. Lawrence. At the same time power was obtained to construct a road on the United States side. In 1887, at a general meeting of shareholders, a split occurred, and two boards were elected, one of which succeeded in retaining the charter already granted. After several failures the other board succeeded in being granted a charter, under the name of the Ottawa, Morrisburg & New York Ry. Co. The latter, however, have never organized, and though they are now applying for a renewal of their charter, the petition is signed by their promoters only. For these reasons the other company contend that they are out of court and that their charter had expired. They also say that they themselves are now connected with the old Waddington road, and they present a letter from Commissioner Oliver W. Barnes stating that they are prepared to go right on with the construction of the road. The opposing company contend that their charter has not expired, and say that they never intended to build the road, but to sell it to some capitalists who should be approved of by the Minister of Railways."

KINGSTON & UTICA.—It is reported that a railway by this name will build a railway from Prattsville to Gilboa, N. Y.

GOSCHEN LATERAL.—The Goschen Lateral Ry. Co. has been chartered in Indiana to build a short line of railway in the town of Goschen, Ind. The officers are Pres., F. E. C. Hawks; Vice-Pres., F. B. Defrees; Secy., H. R. Whitmer, and Treas., E. W. Hawks.

OHIO & VIRGINIA.—A press dispatch says: "The project has been started to give Cleveland a new railroad outlet to the seaboard by way of West Virginia and Virginia, with the Atlantic terminus either at Yorktown or Hampton Roads, Va. The line will traverse the coal and iron districts of three states, and will, if built, divert a great export trade now going via New York. Charters have been secured for the proposed route and the work of organization is now proceeding from the headquarters at Washington. The enterprise is being developed by Cleveland and Washington capitalists, who hope to get a large percentage of the trade that now goes to Buffalo and New York. A survey of the route is to be made in the near future."

PLYMOUTH COUNTY.—John F. Simmons, 55 Equitable Building, Boston, Mass., writes us that the preliminary surveys have been completed for this proposed railway from East Weymouth to Brant Rock, Mass., 25 miles, but that little else has been done as yet.

BINGHAMTON & STATE LINE.—W. P. Pratt, Binghamton, N. Y., writes us that this company, whose incorporation was noted last week, has not been fully organized and that no surveys have been made.

Southern.—Existing Roads.

JACKSONVILLE, ST. AUGUSTINE & HALIFAX RIVER.—It is stated that work will soon begin on an extension from this road to Daytona to New Symrna, Fla.

ATLANTIC COAST LINE.—The extension from a junction with the Albermarle & Raleigh R. R., to Washington, N. C., 25 miles, is practically completed, and will soon be opened for traffic.—Surveys are in progress for the proposed extension from Rimini to Orangeburg, S. C., about 25 miles.

LOUISVILLE, ST. LOUIS & TEXAS.—At a recent meeting of the directors of this company it was decided to build an independent extension from West Point to Louisville, Ky. The line of the Chesapeake & Ohio Ry. Co. is now used between those two places.

KANAWHA & MICHIGAN.—The contract for building the proposed extension of this line from Malden, W. Va., to a connection with proposed branch of the Chesapeake & Ohio Ry., on the Gauley River, has been let to J. S. Casement, of Painesville, O.

BALTIMORE & OHIO.—Work has been commenced on the Fairmont, Morgantown & Pittsburg R. R., near Morgantown, W. Va.

Projects and Surveys.

YAZOO CITY & SILVER CREEK.—Chartered in Mississippi to build a railway from Yazoo City to the Sun Flower and Yazoo rivers.

GLADEVILLE.—Surveys are in progress for this proposed railway from Wise C. H., Va. to Gladeville, Va. Pres., E. M. Fulton, Wise C. H., Va.

GENEVA, FLORALA & PENSACOLA.—It is reported that surveys will soon begin for this proposed railway from Geneva, Ala., to Pensacola, Fla.

ALTAMONT & MANCHESTER.—This company, which was chartered some time ago, has, it is reported, begun construction of its line. Pres., C. Crooke; Sec., F. E. Sampson.

BRUNSWICK, WESTERN & SOUTHERN.—Grading is reported in progress on this line from Wilmington to Southport, N. C. The work is in charge of H. H. Dougherty, Gen. Man., Southport, N. C.

Northwest.—Existing Roads.

KICKAPOO VALLEY & NORTHERN.—Arrangements are being made to begin work on the proposed extension north to Wilton, Wis., 15 miles.

IOWA CENTRAL.—It is stated that this company has offered to build a branch from Eddyville to Ottumwa, Ia., on condition that the people raise $40,000 and grant the right of way and depot grounds.

CHICAGO, BURLINGTON & NORTHERN.—Surveys are to be made for a branch from Prairie du Chien, Wis., to Wauzeka, Wis.

GREEN BAY, WINONA & ST. PAUL.—This company contemplates building a branch from Wausau to Waupaca, Wis. The line will open up a good timber section and considerable local aid can be secured.

SUPERIOR BELT LINE & TERMINAL.—A correspondent writes us that the total length of this line will be 12 miles and that it will extend from the St. Louis River to Allouez Bay. The grading was all done in 1891 with the excention of 2¼ miles of heavy work at the west end of the line. The contract for this section was let to Grant & Foley, who also have the contract for the large ore docks of the Duluth & Winnipeg R. R. at Allouez Bay, and includes 40,000 cu. yds. of grading, 40,000 lin. ft. of piling, 2,000,000 ft. of timber and 140,000 lbs. of iron, bolts and spikes. The company has also let a contract to Kirkland & Starkey for the center pier of the St. Louis River swing bridge and to the King Bridge Co., for one 270-ft. steel swing span, one 150-ft. through span and one 126-ft. deck span. All of the work is to be completed by July 15. The object of the road is to give the Duluth & Winnipeg R. R. terminals at Superior, Wis.

Projects and Surveys.

MASON CITY TERMINAL.—This company has been chartered in Iowa to build and operate railway and telegraph lines. It is stated that a line will be built from Mason City to Manly, Ia. to connect with the Chicago, St. Paul & Kansas City Ry., at once, and that another will ultimately be built northwest from Mason City.

Southwest.—Existing Roads.

TEXAS, LOUISIANA & EASTERN.—The "Beaumont Journal," in speaking of this enterprise says: "Mr. C. M. Putnam, President of the Texas, Louisiana & Eastern R. R., has recently made disposition of all the remaining bonds of the company unsold, to parties in London. This sale, together with recent sale of bonds in this country, will enable the company to finish the construction of the line to the Trinity River at an early date. The company now has its line graded for about 22 miles of the distance east of Conroe, Tex.; the bridging is nearly completed for that distance and steel laid quite a distance into the pinery east of that point. They will begin laying the remainder of the steel necessary to make junction with the Houston, East & West Texas R. R., some time during May, and will reach the Trinity River some time during the summer or in time for the fall trade. The opening of this railroad business will be of great value to the land owners, farmers and others along the line, and as it passes through some of the finest timber and agricultural lands in Montgomery and Liberty counties, the erection of mills for the manufacture of timber will speedily follow the laying of rails."

MISSOURI, KANSAS & TEXAS.—A press dispatch from St. Louis, Mo., says: "It has been learned here that the Missouri, Kansas & Texas officials have determined to build from Elgin, on its main line in Texas, to Austin, the capital, a distance of 26 miles, affording direct connections with the International & Great Northern, Houston & Texas Central and the Austin & Northwestern. The extension of the main line from Boggy Tank to Houston has also been determined on, and people of Houston have raised a guarantee fund. The direction thence to tidewater is not yet fully determined on. Work on the St. Louis line from Franklin to St. Charles, Mo., is in active progress."

NEW ORLEANS & NORTHWESTERN.—It is stated that this company has contracted to build a 7-mile railway from Bastrop to Collins, La.

Projects and Surveys.

LA PORTE & HARRISBURG.—The contract for grading this railway from La Porte, Tex., to Harrisburg, Tex., 8 miles, has been let to J. F. Allen, of Lincoln, Neb. John H. Rice, Ft. Scott, Ark., is interested.

Rocky Mt. and Pacific.—Existing Roads.

SOUTHERN PACIFIC.—The corps of engineers under the direction of W. C. Edes has completed the survey for the proposed branch from Prescott to Phoenix, Ariz.

ASTORIA & PORTLAND.—A force of about 2,000 men are now at work on this line from Astoria to Portland, Ore., clearing the right of way and shipping supplies and material for the construction of the road. The cross-ties will be ready for delivery by June 1, and the rails will be on the ground by July 15.

Projects and Surveys.

ALBUQUERQUE & DURANGO.—A press dispatch from Albuquerque, N. Mex., dated May 20, says: "Benj. F. Cook and W. H. Fowler, of Chicago, are here in the interest of the proposed railway from this section of the Rio Grande Valley to Durango, Col. They start by wagons to-day to go over the line to take careful notes of the country and its resources, and are confident that the business to be had by such a line will warrant its construction. Mr. Fowler is said to represent a strong syndicate of British capitalists. He comes as the confidential agent of the English party to examine the country and report upon the advisability of constructing the line."

NAMPA & SILVER CITY.—R. W. Purdum, of Nampa, Idaho, is at the head of a company which proposes to build a railway from Nampa to Silver City, Idaho.

Foreign.

MEXICO.—The Jalisco Pacific Ry. Co. has been chartered in Colorado. The company proposes to build a railway from Manzilla, in the state of Colima, to Guadalajara, in the state of Jalisco. The capital stock is $10,125,000. The directors for the first year are Chas. W. Drake, Theo. H. Fried, Walter Hinchman, Chas. Meller, Theo. F. H. Meyer, John Pratt and Spencer Trask, all of New York; Jos. A. Davidson, Geo. B. Moffatt, Geo. F. Peabody and Samuel Sewell, of Brooklyn; F. Eugene Crassons, of Hackensack, N. J., and Chas. Peabody, of Englewood, N. J. The same corporation also filed articles for the Zacatecas & Potosi R. R. Co., to build from Zacatecas to San Luis Potosi, with a capital stock of $2,250,000.

ELECTRIC RAILWAYS.

BANGOR, ME.—The Old Town Electric Ry. Co. and the Old Town & Orono Electric Ry. Co. have been consolidated, and the new company will build a freight and passenger line from Bangor to Old Town, 12 miles. J. M. Haynes, F. O. Beall and James Weymouth are among the directors.

COTTAGE CITY, MASS.—The electric railway has been bought by W. A. Boland, and will be extended.

ORANGE, N. J.—The Orange Cross Town & Bloomfield Ry. has decided to adopt the overhead wire electric system

PITTSBURG, PA.—The Pittsburg & West End Ry. Co. has let the contract for construction and equipment to the Westinghouse Electric & Mfg. Co., of Pittsburg: it includes 25 cars, 50 motors and 4 generators. Booth & Flinn are the contractors for the new track.

BALTIMORE, MD.—The Central Ry. Co. will commence work at once on 12 miles of electric road. M. Murray has the contract for new track, with 7-in., 80-lb. girder rails on iron ties.

MACON, GA.—The Thomson-Houston Electric Co. has purchased the City & Suburban and the Central City railways for $105,000 and $95,000, and will equip them for electric traction. There will be 20 miles of line. The Macon & Indian Springs Ry. Co. intends to build an electric road 30 miles long.

NEW ORLEANS.—Specifications for a new electric railway have been prepared by Mr. Brown, City Engineer. The track is to be of girder rails on red swamp cypress ties, and the poles of cedar or iron. The paving is to be of Belgian blocks.

CHILLICOTHE, O.—The street railway has been purchased by Samuel Wood, of New York, and others, who will extend it and adopt electric traction.

SPRINGFIELD, O.—The Citizens' Street Ry. Co. has been granted a 25-year franchise on condition that it replaces the mules by electric traction.

WATERLOO, IA.—The Waterloo Street Ry. & Omnibus Co. has sold out to a company which will adopt electric traction and build an extension to Cedar Falls.

OAKLAND, CAL.—The Alameda, Oakland & Piedmont Ry. Co. proposes to adopt the storage battery or trolley system on its line; 6 miles. Estimated cost, $215,000 for plant; cars, $8,000 each. Pres., Theodore Meetz.

NEW COMPANIES.—Fort Wayne & Belle Isle Ry. Co., Fort Wayne, Ind.; trolley system, to connect with the Detroit Suburban Ry.; N. W. Goodwin, C. E. Kanter and D. M. Ferry, Harrisburg & Mechanicsburg Electric Ry. Co., Harrisburg, Pa.; $75,000; Pres., E. Z. Wallower, Kessler Street Connecting Passenger Ry. Co., Philadelphia, Pa.; $5,000; Geo. D. Widener, G. W. Elkins and J. B. Peddle. Catasauqua & Northern Street Ry. Co.; Catasauqua, Pa.; $50,000, to run to Stemton; Geo. H. Campbell and A. A. Glasier, of Catasauqua, and G. W. Mansfield, of Boston, Mass. Tampa Street Ry. & Power Co., Tampa, Fla.; $500,000; J. R. Ritter, Joseph Wright and J. H. Ahern.

HORSE AND MOTOR RAILWAYS.

PITTSBURG, PA.—The Pennsylvania Street Ry. Co. has been organized, with a capital stock of $30,000, to build a line 5 miles long to Brushtown and Wilkinsburg.

ALBANY, ORE.—The Albany Street Ry. Co. will adopt steam motors in place of horses, and will build five miles of line.

BRIDGETON, N. J.—The Bridgeton Street Ry. Co. has been granted a franchise.

HIGHWAYS.

NEW HAMPSHIRE.—A vote on the building of a road to Pleasant Valley will be held at Center Barnstead, June 9.

NEW YORK.—Proposals for grading and macadamizing roads in Jamaica, N. Y., will be received by F. W. Dunton, 44 Broadway, New York, until June 1.

NEW JERSEY.—A new road is to be built in the western part of Summit township. Address the Town Clerk.

PENNSYLVANIA.—Upper Providence will vote on the issue of $50,000 for five years for road improvements.

OHIO.—Proposals will be received by H. J. Caren, County Auditor, Columbus, O., until June 18, for 5,500 ft. of road work. Roadway, 22 ft. wide, macadamized, and two 6-ft. sidewalks with brick paving and 3-in. curb; 6,905 cu. yds. of fill, 3,514 cu. yds. broken stone, 3,666 sq. yds. boulder guttering, 11,000 ft. of 3-in. curb, 2,444 sq. yds. of brick sidewalk, 4 sewer drops, 20 cu. yds. wet excavation, 10 perches new wall stone, 60 perches old wall stone, 16 perches new covering stone.

MISSOURI.—The road work done under County Surveyor F. J. O'Flaherty, of Kansas City, from December, 1888, to March, 1892, includes 41 miles of macadam roadway, $192,194; 66 miles of grading, $66,880; 182 wooden bridges, $97,210; 55 iron bridges, $114,312, and rock work for culverts and retaining walls, $43,780. About 20 miles of macadamizing are projected for this year.

BRIDGES, TUNNELS AND CANALS.

WAREHAM, MASS.—Sealed proposals will be received until June 3 by Joint Board of Co. Comrs. of Barnstable and Plymouth counties, Mass., for building the masonry abutments of a bridge over Cohasset Narrows, between towns of Bourne and Wareham. All plans must be made in accordance with plans and specifications, which will be furnished upon application to Edward S. Shaw, C. E., 146 Franklin St., Boston. Proposals will be received as follows: (1) For cubic yards of excavation for foundations; (2) for cubic yards of concrete in foundations; (3) for cubic yards of stone masonry in abutments. Saml. Snow, John K. Clark, Walter H. Founce.

GOUVERNEUR, N. Y.—This city has appropriated $12,000 for a new bridge, and the Commissioners will take immediate steps for its construction.

LEICESTER, N. Y.—The Schuylerville River bridge is to be replaced by an iron and stone structure to cost $4,000.

MIDDLETOWN, N. Y.—A special appropriation of $8,000 has been made for the rebuilding of the Highlands bridge. Chairman of Committee on Bridges will give details.

COLUMBUS, O.—Bids will be received until June 1 for constructing the proposed viaduct over the railway tracks at High St. The estimated cost of the work is $413,000. Plans and specifications can be seen at the City Engineer's office.

TROY, O.—Sealed proposals will be received until June 18 for labor and material required for the construction of a high truss iron bridge over Honey Creek near Tippecanoe City. E. F. Furnas, Co. Auditor.

RIVERTON, VA.—Sealed proposals will be received until June 1 for the stone work and superstructure of two iron bridges across the Shenandoah River. Plans may be seen on application to F. B. Morse, Crown Royal, Va.

FT. SHERIDAN, ILL.—Sealed proposals, in triplicate, will be received at the office of the Construction Quartermaster until June 15, 1892, and opened immediately thereafter, for the material and labor required to build four iron deck bridges over ravines on the military reservation of Fort Sheridan, Illinois.

OXFORD, NEB.—A new iron bridge is to be built across the Republican River at this place, to accommodate the counties of Furnas and Harlan.

CENTERVILLE, IA.—The Board of Supervisors of Appanoose Co. will receive bids and examine plans at their June session in 1892 with a view to making yearly contracts for the separate bridge district of said county. R. M. Hicks, A. G. Davidson, H. L. Holliday, Board of Supervisors.

LAWRENCE, KAN.—Sealed proposals will be received by the Commissioners of Douglas County, Kan., at the office of the County Clerk until June 3, for building two bridges as follows: One iron bridge across the Wakarusa River at a point in Eudora township; one span 110 ft. in length, roadway, 14 ft. in the clear, with 46-ft. of approach, 16 ft. on east end, and 30 ft. on west end, substructure to consist of two iron tubes under west end 30 ft. high and 3 ft. in diameter, stone pier under east end 7 ft. high, stone abutment under east approach 7 ft. high with wing walls, pile approach at west end.—One bridge across Rock Creek in Clinton township, one span 70 ft. in length and 14 ft. roadway in the clear, with 75 ft. of pile approach, 30 ft. on the west end and 45 ft. on the east end. Bids will be received on this bridge for either iron or wood.

WATER-WORKS.

New England.

MEREDITH, N. H.—A committee has been appointed by the fire precinct to investigate the subject of building works. A supply is proposed from a spring on the land of J. W. Lang.

BOSTON, MASS.—The Aldermen have voted in favor of a loan of $75,000 for extending the high service system of the Cochituate works. This sum probably covers work for which bids are already in.

BROOKLINE, MASS.—D. H. Cram, the lowest bidder, has the contract for the 1,000,000-gallon covered reservoir for $22,778.

CHICOPEE, MASS.—A Special Council Committee has recommended that the city buy the plant of the Chicopee Water Co., and take for a new supply water from four brooks.

HOLYOKE, MASS.—A dam about 10 ft. high, to form a reservoir on Crystal Spring Brook, is proposed; also a 16-in. main 1,600 ft. long, leading from the dam to the city distribution.

LYNN, MASS.—It is stated that the Water Committee of the Legislature will report in favor of allowing the city to borrow $150,000 for increasing the water supply.

PITTSFIELD, MASS.—It is reported that the Town Treasurer has been authorized to make a loan of $15,000 for an increased water supply, water to be taken from Hathaway Brook.

WEBSTER, MASS.—The legislative Water Committee has reported a bill authorizing the town to issue $150,000 of 5%, 30-year bonds for works, with a supply from Lake Chaubunagungamaug. The town is partially supplied by private works.

WINCHESTER, MASS.—The town has voted $14,000 for a main from the south reservoir to Main St.

WORCESTER, MASS.—The Council Water Committee has recommended that several hundred feet of 6 and 8-in. cement lined pipe be replaced with cast iron and that some additional cast iron pipe be laid.

BETHEL, CONN.—It is reported that a 12-in. main will be laid to the city from Mountain Pond at a cost of about $10,000.

FAIRPORT, CONN.—R. S. Hicks has made a proposition to build private works here.

SOUTHINGTON, CONN.—It is reported that the company has decided to meter all consumers soon.

SOUTH NORWALK, CONN.—The borough has referred to a special committee the question of building a new storage reservoir.

WESTPORT, CONN.—Marsh, Lemon & Co., of Bridgeport, have arranged to build the works projected for some time by the Westport Water Co. A well, pumping station and reservoir are projected.

Middle.

AUBURN, N. Y.—The city has obtained authority to establish municipal works, provided the people vote for the same. A company now supplies the city.

BROOKLYN, N. Y.—The Long Island Water Supply Co., of the 26th Ward, has been ordered to place 200 hydrants.

CARTHAGE, N. Y.—An election will be held June 7, to vote on raising $50,000 for works. The plan includes a water power pumping plant, stand-pipe or reservoir, 383 tons of pipe and 50 hydrants. E. H. Myers, Pres. Village Trustees.

FAYETTEVILLE, N. Y.—It is estimated that works could be built for about $25,000, including about five miles of cast iron pipe, 40 hydrants and a reservoir 100 ft. square by 10 ft. deep. Engr., E. D. Smalley.

FRANKFORT, N. Y.—We are informed that the Stanwix Engineering Co., Rome, N. Y., is making surveys and plans for works here.

LESTER SHIRE, N. Y.—The Lester Shire Water-Works Co., of Binghamton, has been incorporated by G. Harry Lester, of Lester Shire, Wm. B. Brewster, and others, of Binghamton; capital stock, $50,000.

MECHANICVILLE, N. Y.—The Commissioners will issue $88,000 of water bonds.

NEW YORK, N. Y.—Bids for building the large new Croton dam at the Cornell site are asked in our advertising columns. It is estimated that the dam will cost $4,000,000.

TICONDEROGA, N. Y.—See proposals columns for information regarding new village works.

WARSAW, N. Y.—The company proposes to build a 10,000,000-gallon storage reservoir. Engr., J. O. McClure.

ELIZABETH, N. J.—The company has been ordered to add 50 hydrants.

RIDGEWOOD, N. J.—Works are projected by John H. Van Steenburgh, with a supply from Saddle River, pumped to a reservoir.

WEST ORANGE, N. J.—A proposition to supply the town has been made by Engr. C. Ph. Bassett, Newark. A local company with a supply from the existing Summit Water Co. is proposed.

BELLE VERNON, PA.—A charter for water and electric lighting company will applied for.

ELKLAND, PA.—Works are being discussed by the taxpayers.

HARRISBURG, PA.—Bids will be received until May 28 by E. Mather, Pres., Water Comrs., for furnishing hydrants, valves, pipes, special castings and corporation ferrules for the year ending June 1, 1892.

HOMESTEAD, PA.—Extensions at a cost of $30,000 are proposed by the borough.

LANCASTER, PA.—Bids for a new 15,000,000-gallon reservoir ranged from $64,000, by S. W. Frescoln, C. E., New York, to $127,000, by J. Schinneller, Pittsburg. For a 20,000,000-gallon reservoir the lowest bid was $85,000, by Mr. Frescoln, and also by Owen Patterson, Baltimore, and the highest, $182,000, by W. M. Chisholm, East Liverpool, O. The contract was awarded to Mr. Frescoln, for the smaller reservoir, the city having the option of building which it chose. A contract for a 10,000,000-gallon high duty pumping engine has been awarded to H. R. Worthington, New York, at $38,000.

LITITZ, PA.—The Lititz Water Co. has voted to increase its capital stock from $5,000 to $25,000, in order to enable it to supply water for all purposes instead of for street sprinkling only.

PITTSBURG, PA.—A new reservoir is proposed, and 50 acres of land will be bought.

PLAINS, PA.—An effort is being made to force the Plains Water Co. to furnish water or give up its charter.

STEELTON, PA.—It is reported that works are again talked of.

BOONSBOROUGH, MD.—The Boonsborough Water-Works Co. is securing estimates on works.

BALTIMORE, MD.—The Baltimore & Curtis Bay Light & Water Co. proposes to increase its capital stock to $100,000, sink wells, erect a stand-pipe, put in mains and an electric lighting system.

FROSTBURG, MD.—Address A. C. Haverstick regarding improvements to the works.

Southern.

PIEDMONT, W. VA.—The probable cost of works is being determined by the Council.

ATHENS, GA.—Bids for constructing city works will be received until June 6. There will be a 20 × 75-ft. stand-pipe on a 75-ft. trestle. The water will be filtered through gravity filters. Bonds to the amount of $125,000 have been sold to Farson, Leach & Co., New York. Consult. Engr., R. Hering, New York.

GRIFFIN, GA.—Henry R. Burr has been appointed receiver of the Griffin Water-Works Co., with orders to sell the works within 60 days.

ARCADIA, FLA.—The Arcadia Water-Works Co. has been incorporated by R. L. D. Rosenthal, E. M. Ernest and others; capital stock, $12,000.

ORLANDO, FLA.—It is reported that the company's works will be sold to satisfy a suit for $100,000.

MOBILE, ALA.—Engr., S. M. Gray, Providence, R. I., has been employed by the city to report on the water-works and sewerage systems.

TROY, ALA.—Engr. N. Wilson Davis, Atlanta, Ga., informs us that the city's 10-in. well is now down 800 ft. When the well is finished $37,000 works will be built.

PORT GIBSON, MISS.—The Port Gibson Water & Light Co. has been incorporated; capital stock, $150,000.

BARDWELL, KY.—Works are proposed.

LUDLOW, KY.—June 4 the people will vote on issuing $25,000 of bonds for works.

NICHOLASVILLE, KY.—Works are projected.

North Central.

GREENVILLE, O.—Works are talked of. The Mayor seems to favor municipal ownership.

HILLSBORO, O.—The town has voted to build $75,000 works.

RIPLEY, O.—Surveys are being made for works estimated to cost $25,000.

WAPAKONETA, O.—Engr. J. W. Hill, Cincinnati, has been engaged to design works.

WYOMING, O.—Bids for $35,000 of 5% city water bonds will be received until June 16. Address W. A. Clark, Clk.

ANDERSON, IND.—Improvements are projected which include a new pumping station and new mains; estimated cost, $60,000.

GOSHEN, IND.—Bids are wanted by the Water-Works trustees until May 30 for furnishing and placing about 5,500 ft. of 8-, 6- to 6-in. cast iron pipe, specials and 18 hydrants.

ROCHESTER, IND.—It is reported that works will be built.

CADILLAC, MICH.—Bids for a franchise are wanted. Address the City Clerk.

MAYVILLE, MICH.—The village has voted bonds for works by 22 majority.

DANVERS, ILL.—Contracts for works have been let by the town. A. S. Hart, Normal, will erect a 20 × 24-ft. tank on a 50-ft. brick tower; Kinsley & Mahler, Peoria, will put in the pump, boiler and mains.

MOUNT CARMEL, ILL.—The town will grant a franchise for water and electric lighting plants. Address R. T. Wilkinson.

EAU CLAIRE, WIS.—Cy. Engr. C. A. Alderman is preparing plans for the extension of mains in Forest Hill Cemetery.

HUDSON, WIS.—We are informed that the city has contracted for a 1,300,000-gallon pumping engine.

Northwestern.

LYONS, IA.—The Lyons Water-Works Co., it is reported, has increased its capital stock from $75,000 to $200,000.

RENVILLE, MINN.—Bids will be received until June 9 for the construction of works. Address R. T. Daly, Village Recorder, or J. T. Brooks, Prest. Council.

RAPID CITY, S. DAK.—Bids will be received by the City Auditor until June 6 for material and labor connected with building a reservoir and laying 19,000 ft. of 10-in. cast iron mains.

BUTTE, MONT.—Bids for a franchise are asked in our advertising columns. Cy. Clk., John McCrimmon.

Southwestern.

KANSAS CITY, MO.—Bids will be received by the city until June 20 for $2,000,000 of 4½% 20-year gold bonds. Benj. Holmes, Cy. Comptroller.

HUNTINGTON, ARK.—Engr. Geo. W. Crawford has been making surveys for works.

VAN BUREN, ARK.—It is reported that bids for a franchise are wanted. Address E. L. Matlock, Cy. Clk.

CAMERON, TEX.—Works are being discussed.

CANADIAN, TEX.—It is reported that works will be built.

CLIFTON, TEX.—Works will be built, according to reports.

CUERO, TEX.—Bonds to the amount of $7,000 will be issued for new mains.

DUBLIN, TEX.—The Dublin Light & Water Co. has been incorporated; Directors, J. B. Green and others; capital stock, $40,000.

HENRIETTA TEX.—Address Secretary Board of Trade regarding proposed works.

ROCKPORT, TEX.—A stand-pipe system is proposed by the Rockport Water-Works Co., recently incorporated, provided the Council will contract for 30 hydrants.

VALLEY MILLS, TEX.—Construction of works was to be started May 13.

FLETCHER, COLO.—Mains are being laid.

Pacific.

NEW WHATCOM, WASH.—There is talk of the purchase of the private works by the city.

PORT TOWNSEND, WASH.—A committee has been appointed to confer with the company on the purchase of the latter's works.

RIVERSIDE, CAL.—There is talk of the city buying the various domestic water plants.

OGDEN, UTAH.—An ordinance is before the Council granting a franchise to Alonzo Hertig, Chicago, allowing him to build works, using for a supply the city's water rights, of 60 cu. ft. per sec., from the Weber River, through the Weber Canal. A company already supplies the city.

PHOENIX, ARIZ.—W. B. Clapp, Pasadena, will make plans for new works.

Canada.

MONTREAL, P. Q.—Bids for about 25,000 lbs. of stop cock, branch and 20 to 4-in valve brass castings will be received by the Water Committee until May 31. J. O. A. Laforest, Acting Supt.

REGINA, N. W. T.—The Council has decided to expend $30,000 for works.

ARTESIAN WELLS.

MINOT, N. DAK.—A well is projected, the Council having offered to aid in sinking one.

YANKTON, S. DAK.—An artesian well for power is talked of.

GROESBECK, TEX.—Bonds for a well will be issued.

MIDLAND, TEX.—A well is being discussed.

IRRIGATION.

GRAPELAND, CAL.—Bids are wanted until June 7 by the Grapeland Irrigation District for constructing 2,850 ft. of tunnel and 9,000 ft. of canal. Engr., F. C. Finkle, San Bernardino, Cal.; Secy., E. T. Myers.

NEW COMPANIES.—Hartsel Hot Springs Reservoir Co., Hartsel, Colo.; Directors, Arthur Meek, R. H. Malone and others; $300,000; to build a reservoir to store water of the South Platte River, in Park Co. Agricultural Ditch Co., No. 2, Clearwater, Cal.; Directors, J. W. Venable, Daniel Lane and others; $10,000. Laredo Canal Co., Bakersfield, Cal.; Directors, Wm. S. Tevis, S. W. Ferguson and others. Cold Water Creek Irrigation Co., Ogden, Utah; $162,000. Nicaragua Water; Irrigation & Electric Co., Republic of Nicaragua Directors, J. J. and G. C. Jewett, Petaluma, W. C. Quimby, San Francisco and others; $250,000.

SEWERS.

BERLIN, N. H.—The town has appropriated $20,000 for a system of sewers.

CONCORD, N. H.—A system is to be constructed in West Concord.

ROCHESTER, N. H.—The city has voted in favor of the proposed system. The total length is about 15 miles, and estimated cost, $65,000.

BOSTON, MASS.—Bids are asked until June 4 for Section 41 of the main sewer, in Malden and Melrose. See advertisement.

HAVERHILL, MASS.—The City Engineer has reported plans for sewers in Ward 6. The separate system is recommended.

NORTHAMPTON, MASS.—The Council has appropriated $75,000 for a sewer to Florence.

NORTH ANDOVER, MASS.—Bids are asked until June 15 for plans and estimates for a town system. Address D. W. Carney.

EAST GREENWICH, R. I.—It is proposed to form a corporation to put in a system. S. M. Knowles is a member of a committee appointed to investigate the cost.

PROVIDENCE, R. I.—The House of Representatives has passed a resolution authorizing the Governor to appoint a Commission to report upon the practicability of building a large sewer parallel to the Pawtuxet River, to begin at the first manufacturing village and extend below the water-works pumping station.

NEW HAVEN, CONN.—The City Engineer has been authorized to ask for bids for the Mansfield sewer.

AMSTERDAM, N. Y.—The Council has elected the following Sewer Commissioners: H. Putnam, I. Adler, J. Kelly, Jr., J. T. Sugden.

FLATBUSH, N. Y.—The following bids have been received by S. E. McElroy, C. E.: J. H. O'Rorke, $172,003 for vitrified pipe, $172,319 for cement; John Crook, $190,090, $193,385; D. J. Creem, $184,067, $181,045; John Brey, $172,871, $164,035; Jas. Graham, $188,140, $181,117.

GLENS FALLS, N. Y.—The citizens have voted in favor of the proposed sewers. S. E. Babcock, Little Falls, prepared the plans, and the estimated cost is $167,605.

ILION, N. Y.—Plans for a complete system are being prepared by the Stanwix Engineering Co., Rome.

ERIE, PA.—A special meeting will be held to discuss the issuing of bonds for $150,000 for sewers.

NANTICOKE, PA.—The lowest bid for the main sewer was that of Coon & Mooney, $17,713, and the highest, $36,574. The estimate for the entire system is $78,500.

PHILADELPHIA, PA.—An ordinance is before the Council authorizing a loan of $250,000 for a main sewer in Pasayunk Ave.

WILKINSBURG, PA.—Plans for the proposed system are being prepared by Edeburn & Cooper. The length will be about 20 miles, and $160,000 has been voted for the construction.

YORK, PA.—The Committee on Highways has recommended the employment of an engineer to prepare surveys and plans for both surface and sanitary drainage.

HUNTINGTON, W. VA.—The Street Committee has been instructed to ask for bids for the brick work of the Eleventh and Sixteenth St. sewer.

MOBILE, ALA.—The city has engaged S. M. Gray, Providence, R. I., to prepare plans and estimates for sewerage and water-works.

FORT WAYNE, IND.—Bids are asked until June 14 for a 42-in. double ring brick sewer in one street, and 15-in. pipe sewers in two streets. F. M. Randall, Cy. Engr.

CHICAGO, ILL.—The Council has passed ordinances for main sewers to cost $250,000.

WAUKEGAN, ILL.—Bids are asked until June 20 for constructing sewers. John A. Cole, Chicago, is the Consulting Engineer. See advertisement.

WATERLOO, IA.—Plans and specifications for a sewerage system have been prepared by John A. Cole, Chicago, and the Council has the question of construction under consideration.

WEST DULUTH, MINN.—John Krey, Cy. Engr., writes us that contracts for about half a mile of storm sewer will be awarded June 6, but that otherwise little sewer work will be done this season, owing to delay in the plans.

FORT DODGE, IA.—Plans for a system are being prepared by C. F. Loweth, St. Paul, Minn.

OMAHA, NEB.—Bids are asked until June 3 for sewers in three districts. P. W. Birkhauser, Chn., Bd. Pub. Wks.

AUSTIN, TEX.—The City of Austin Sewerage Co. has been organized to construct a system of sewerage. Col. C. Delafield, New York, will prepare the plans, and C. A. Newning and W. B. Brush will have charge of the construction.

BEAUMONT, TEX.—Bids are asked until June 7 for a system of sewerage. W. A. Ives, Mayor.

GREAT FALLS, MONT.—The city will construct a main sewer this summer to cost about $35,000.

WOODLAND, CAL.—The lowest bid for the proposed sewerage system was that of the California Bridge Co., San Francisco, $17,550.

STREETS.

TAUNTON, MASS.—It is reported that $20,000 will be spent in paving.

BUFFALO, N. Y.—Bids are asked until June 2 for resurfacing two streets with Trinidad Lake asphalt. E. F. Bishop, Secy., Bd. Pub. Wks.

NEW YORK, N. Y.—The Commissioner of Public Works has been authorized to ask for bids for the repaving of 31 streets with granite blocks on concrete at an estimated cost of $519,000, and five streets with asphalt on present stone blocks, $131,200. Also, to employ during 1892 a consulting engineer, assistant engineer, draftsman, etc. Bids are asked until June 1 for paving with asphalt, six contracts. T. F. Gilroy, Comr. Pub. Wks.

ROCHESTER, N. Y.—The Council has voted in favor of paving one street each with brick, asphalt and macadam. The contract for paving Plymouth Ave. has been awarded to the Warren Scharf Asphalt Co. at $58,460. The estimate was $74,000.

TROY, N. Y.—The Committee on Streets has voted to pave one street with asphalt, and two streets with granite.

HOMESTEAD, PA.—A special election was held May 24 to vote on the issue of bonds for $105,000, of which $55,000 is to be used for paving and street improvement.

NORRISTOWN, PA.—The Council has voted to pave two streets, to cost $40,000 to $58,000, according to material.

FORT MONROE, VA.—Bids are asked until June 9 for 32,000 hard burned paving brick and 72,000 bu. oyster shells. Capt. J. W. Fuliman, Asst. Q. M., U. S. A.

HUNTINGTON, W. VA.—The Committee on Streets will receive bids for paving five squares.

NASHVILLE, TENN.—The Council has voted to issue bonds for $60,000 to widen and pave certain streets.

MEMPHIS, TENN.—Bids are asked until May 31 for sand, cement, laying brick pavement, etc. Plans at office of City Engineer.

ASHTABULA, O.—At least one street, it is said, will be paved with fire brick.

CLEVELAND, O.—The estimate for the year includes $230,000 for paving.

DAYTON, O.—The City Engineer is preparing plans for paving one street with sheet asphalt and brick.

SALEM, O.—The contract for paving 10,948 sq. yds. with brick has been awarded to Carroll & Landis, Wooster, $18,800.

TOLEDO, O.—Bids are asked until June 13 for three contracts, brick, asphalt and turnpiking. S. Lamb, Cy. Clk.

TIFFIN, O.—Bids are asked until June 3 for paving one street with fire brick. J. Rex, Cy. Clk.

FORT WAYNE, IND.—Bids are asked until June 14 for paving one alley with brick, and constructing brick sidewalks in seven streets. F. M. Randall, Cy. Engr.

KOKOMO, IND.—Bids are asked until June 6 for improving four streets. D. A. Smith, Cy. Clk.

RICHMOND, IND.—Bids are asked until June 3 for paving three streets with brick, and one street with cobble stones. C. G. Swain, Clk. Bd. Pub. Wks.

DETROIT, MICH.—The lowest bids for paving two streets were those of the Talbot Paving Co., brick, $54,113 and $52,034. For asphalt, the lowest were $71,049 and $96,436.

MONROE, MICH.—The city will spend $25,000 in paving.

PEKIN, ILL.—Bids are asked until June 6 for gravelling one street. L. Zinger, Chn., Com. on Sts.

TIPTON, IA.—Bids are asked until June 7 for 4,000 ft. of concrete walks. A. B. Laubscher, Co. Auditor.

ELECTRICAL.

LEOMINSTER, MASS.—The Leominster Electric Light & Power Co. is about to add to its plant a 300-HP. condensing engine, two 125-HP. steel boilers, and one 1,300 light incandenscent dynamo.

CLYDE, R. I.—The Peoples' Edison Power & Illuminating Co. is reported about to put in an arc system of 1,200 c. p., a new dynamo, and about three miles of wire; also an alternating system to Crompton and Natick.

FAIR HAVEN, CONN.—The citizens desire electric street lights. Willis Henungway is interested.

WATERBURY, CONN.—Bids will be received until July 1 for city lighting. J. J. Cassin, Cy. Auditor.

HAVERSTRAW, N. Y.—The Electric Light & Power Co. will enlarge its plant. B. B. Odell, Jr., Pres.

LANSINGBURG, N. Y.—The village trustees favor a plan providing for 180 lamps of 2,000 c. p. It is proposed to call a special election before asking for bids.

NORTH TONAWANDA, N. Y.—The Council has voted to extend the electric light to Martinsville.

SILVER CREEK, N. Y.—The citizens have voted in favor of electric street lighting. A plant to cost about $20,000 will be put in by residents of the village.

SHARPSBURG, PA.—The Council has voted in favor of a municipal plant.

LEXINGTON, VA.—The city has contracted with T. W. Shelton and W. H. Waddell to erect a plant, work to commence by Sept., and be completed Jan. 1, 1893; capacity, 1,000 incandescent and 50 arc lights.

MOBILE, ALA.—The Electric Light Co. will increase the capital stock $100,000, and enlarge its plant. S. S. Rubira, Pres.

STAMFORD, KY.—The Stamford Water, Light & Ice Co. will put in an electric light plant; capital, $10,000.

PERRY, IND.—The Council desires a plant in which the city shall have an interest.

MINNEAPOLIS, MINN.—The City Clerk will receive bids for 600 to 1,000 arc lights, 2,000 c. p., for a five years' contract, the bids to be opened by the Council at the first meeting in June.

MOSCOW, IDAHO.—The electric light plant is to be improved, and 700 incandescent and 50 arc lights added.

NEW COMPANIES.—Newtown Electric Light & Power Co., Newtown, N. Y., and Newark, N. J.; $150,000; J. A. Seely, Brooklyn, N. Y.; G. O. Baker, Jr., Newark. Compound Electric Motor & Dynamo Co., Chicago, Ill.; $500,000; C. T. Brown, A. J. Robertson. Pumpelly Storage Battery Co., Chicago, Ill.; $40,000; J. K. Pumpelly, W. I. Maddock. Garden Electric Co., Chicago, Ill.; $100,000; B. Elliott, 747 Fifty-ninth St. Lacon Electric Co., Lacon, Ill.; $16,000; Pres., I. S. Baldrich. Tenafly Electric Light Co., Tenafly, N. J.; $10,000; S. T. Atwood, E. M. Smith. Edison Electric Light & Power Co., Trenton, N. J.; $200,000; F. A. Magowan, W. P. Hayes. Ukiah Electric Co., San Francisco; $30,000; G. B. Johnson, J. W. Smith.

CONTRACT PRICES.

DREDGING.—Toronto, Ont.—The Toronto Dry Dock Co. has been awarded the contract for dredging at Center Island, at 32 cts. per cu. yd. This includes the filling up of lagoons with the material taken from the channel.

STREET WORK.—Altoona, Pa.—The contract for paving with Trinidad asphalt has been awarded to the Barber Asphalt Paving Co., at $3 per sq. yd.; new curb, 75 cts., and resetting old curb, 10 cts. per lin. ft.

Dayton, O.—There were 24 bids received for cement sidewalks, all at 14 cts. per sq. ft.

SEWER SUPPLIES.—Seattle, Wash.—Contracts for material for the Lake Union sewer tunnel have been awarded as follows: Schwabacher Bros., cement, $2.69 per bbl., delivered in 100 barrel lots; Puget Sound Brick, Tile & Terra Cotta Co., brick, $8.75 and $12 per M. for inside and outside courses, respectively; H. C. Nissen, screened gravel, $2.30 per cu. yd.

LUMBER.—Milwaukee, Wis.—The only bid for furnishing the city with lumber during 1892 was that of John Schroeder: common pine flooring, $19 per 1,000 ft.; white oak, $23; common pine, $12; hemlock, $9.25.

CEMENT.—Minneapolis, Minn.—The contract for furnishing the city with cement has been awarded to the Twin City Lime & Cement Co. at the following prices: Mankato, 89 cts. per bbl. in wood 72 cts. in paper sacks 62 cts. in cloth sacks; Milwaukee, 98 cts., 76 cts., 60 cts.; Louisville, $1.02, 82 cts., 77 cts.; 15 cts to be changed for each unreturned cotton sack, and 5 cts. credited for each returned barrel.

INDIANAPOLIS, IND.—Three contracts have been awarded to the Capital Paving & Construction Co. as follows: Wabash clay brick, width of street 50 ft., $4.81 per lin. ft., with ooditic curb; width 60 ft., $5.56 and $5.58, with Parkhurst curb.

ROADS.—Chester, N. J.—The contract for about 12 miles of roads has been awarded to B. & J. F. Shanley, Jersey City, at 92 cts. per sq. yd. for telford, and 79 cts. and 67 cts. for 8-in. and 6-in. macadam, respectively.

MISCELLANEOUS.

CEMENT.—Washington, D. C.—Bids will be received until May 31 for 100,000 lbs. cement. Edwin Stewart, Paymaster-General, Bureau of Provisions and Clothing, Navy Department.

GAS.—Camden, N. J.—The Chemical Gas Co. has been incorporated by M. W. Stroud, Philadelphia, and N. W. Cox, Camden; capital, $500,000.

DREDGING.—Albany, N. Y.—Bids are asked until May 31 for dredging 37,000 cu. yds. in the Hudson River at Stuyvesant. Edward Hannan, Supt. Pub. Wks.

STONE WORK.—St. Louis, Mo.—Bids are asked until Jan. 3 for the cut stone work of the new City Hall. Geo. Burnet, Pres., Bd. Pub. Impr.

GAS WELLS.—Findlay, O.—Proposals will be received until June 14 for drilling 20 wells. Frank Talbot, Supt., Gas Trustees.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have an order for four engines for the Staten Island Rapid Transit, and have delivered a dummy engine to the street railway at Seymour, Ind. The Rhode Island Locomotive Works, Providence, R. I., have an order for 15 ten-wheel and 5 switch engines for the Ohio & Mississippi. The Schenectady Locomotive Works, Schenectady, N. Y., have an order for three consolidation engines for the Fall Brook.

NOTICE TO CONTRACTORS.

Sealed proposals will be received by the Water-Works Commission of the city of Athens, Ga., until 12 o'clock noon, city time, of Monday, June 6, 1892, for the following:

Construction of pump, boiler, filter and gatehouse, intake weir, clear water basin, chimney, 6 ft. in diameter, 115 ft. high, and for laying 20-in. intake pipe from river to pump well and improving the existing pond and grounds; also, for furnishing and laying 2,200 tons cast iron water pipe and specials from 6 to 18 ins. in diameter, 150 post hydrants, 72 valves, 1 stand-pipe 150 ft. high, 2 compound duplex condensing pumps of 1,500,000 gallons each and 4 60-H.P. return tubular boilers.

Plans, profiles and specifications can be seen at the office of the city engineer after May 28, 1892. A certified check of $500 must accompany each bid. The right is reserved to reject any and all bids.

J. H. RUCKER,
A. L. HULL,
C. M. STRAHAN,
Commission.

J. W. BARNETT, City Engineer. 22-2t

TO BRIDGE BUILDERS.

PROPOSALS FOR THE CONSTRUCTION OF AN IRON OR STEEL BRIDGE.

Sealed proposals will be received until 7 o'clock p. m., June 24, 1892, for furnishing all materials and labor, and constructing the substructure and superstructure of an iron or steel bridge across the Connecticut River between Thompsonville and Sumeld, Hartford Co., Conn. The distance between abutments is to be 1,000 ft., and bids are called for upon a bridge having a clear roadway of 18 ft., and upon a bridge having a clear roadway of 20 ft.

Bidders will be required to make their own surveys, and to determine for themselves the length of spans and location of piers.

The profile of the river can be seen, and specifications be obtained upon application to Willis Gowdy, Treas., Thompsonville, Conn.

All bids must be accompanied by a certified check for $1,500, payable to the order of Willis Gowdy, Treas., of the Sumeld & Thompsonville Bridge Co., duly certified by the bank upon which the same is drawn. Such checks will be returned in cases where bids are not accepted, and in the case of the successful bidder, upon the execution of a bond to the amount of 25% of the contract price, to be approved by the undersigned, conditioned for the faithful performance of contract.

All bidders will be required to submit full plans and specifications with each bid, and the successful bidder will be required to submit full working drawings of all work before commencing work.

Bids may be forwarded by mail or otherwise, but must be in the hands of the undersigned on or before the time hereinbefore mentioned, at which time the bids will be opened. The right to reject any or all bids will be reserved by the Bridge Co.

THE SUFFIELD & THOMPSONVILLE BRIDGE CO.

Thompsonville, Conn. 22-1t

Office of the
Commissioners of the District of Columbia,
Washington, May 25, 1892.

PROPOSALS FOR CLEANING ALLEYS in the Cities of Washington and Georgetown, D. C.

Sealed proposals will be received at this office until 12 o'clock m., Tuesday, June 7, 1892, for sprinkling, sweeping and cleaning the paved and unpaved alleyways in the District of Columbia during fiscal year to end June 30, 1893. Separate bids will be received for cleaning unpaved alleys. Blank forms of proposal and specifications can be obtained at this office upon application therefor, together with all necessary information, and bids upon these forms will alone be considered. The Commissioners reserve the right to reject any and all bids or parts of bids, and in case two or more bids shall be for the same amount, to accept the one which, in their judgment, will be most conducive to the public interest.

J. W. DOUGLASS,
J. W. ROSS,
W. T. ROSSELL,
Commissioners, D. C.
22-2t

FOR SALE.

One 8-ton, 3-ft. gage Porter locomotive; immediate delivery. One ton, same gage and make; three weeks' delivery. Address BRENDLINGER & NEARING, Buffalo.